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THE UNIVERSITY
OF MICHIGAN
APR 6 1961
ENGINEERING

NUCLEAR SCIENCE ABSTRACTS

Volume 15 Number 6A

Abstracts 5851–7123

March 31, 1961

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NOTICE

Beginning with this issue of *NSA*, a new subcategory is introduced under the main category PHYSICS. It is entitled Neutron Physics. The definition of this new subcategory is as follows:

Includes experimental and mathematical treatments of neutron absorption, attenuation, moderation, multiplication, scattering, etc., in real and hypothetical media. Such studies conducted for a specific, indicated application are categorized according to the application, e.g., REACTOR TECHNOLOGY, PHYSICS—Criticality Studies, and PHYSICS—Shielding. Neutron reactions with specific nuclei are categorized under PHYSICS—Nuclear Properties and Reactions.

NUCLEAR SCIENCE ABSTRACTS

Volume 15, Number 6A

March 31, 1961

GENERAL AND MISCELLANEOUS

5851 (ANL-6183) CHEMICAL ENGINEERING DIVISION SUMMARY REPORT [FOR] APRIL, MAY, JUNE 1960. (Argonne National Lab., Ill.). 178p. Contract W-31-109-eng-38. OTS.

Chemical-Metallurgical Processing. A direct-cycle fuel-reprocessing plant using pyrometallurgical procedures is being designed and constructed as part of the Experimental Breeder Reactor No. 2 project. Cable samples sealed with Temporell No. 741 were irradiated to 3.0×10^9 rad. Tests of the absorber-type fume trap were successful. Preparations were continued for high-activity-level demonstrations of the melt-refining process for EBR-2 core fuel. An attractive and efficient procedure for removing uranium skull material from a melt-refining crucible is to convert it to free-flowing oxide powder by oxidation with a dilute oxygen–argon mixture at 700 to 800°C. Two complete runs were made for both demonstrating and pin-pointing difficulties in the drag-out or skull-reclamation process. Investigation of the reduction of uranium oxides by liquid magnesium alloys was continued. Two runs were made to demonstrate recovery of plutonium from a magnesium solution by distillation of the magnesium. Operation of a mild steel corrosion loop for circulating a U–Mg–Cd alloy at 550°C was terminated after 4800 hr of trouble-free operation. The solubility of titanium in liquid cadmium was found to vary between 0.047 at. % at 449°C to 0.15 at. % at 651°C. The solubility of uranium in liquid lead over the temperature range from 415 to 802°C is given. The solubility of uranium in cadmium–magnesium solutions containing up to 72 wt. % Mg at 610°C was found to decrease smoothly from about 2 wt. % in pure cadmium to about 0.002% in 72 wt. % Mg. The partition coefficients of a number of representative fissile and fission product elements between the immiscible liquids aluminum and cadmium at 680 to 688°C were measured. The heat of combustion of tungsten disulfide in oxygen was determined to be $\Delta E_c^0/M = -1939.29 \pm 0.55$ cal/g for the reaction. The heat of formation of ZrF_4 was determined by combustions of Zr in F_2. Two series of calorimetric combustions of B in F_2 were carried out. Fuel-Cycle Applications of Volatility and Fluidization Techniques. The Direct Fluorination Volatility Process is being developed to recover uranium and plutonium from spent uranium oxide, Zircaloy-clad fuel elements of the type used in the Dresden nuclear power plant. A study of the kinetics and mechanism of the decomposition of PuF_6 vapor was initiated. The reaction of PuF_6 with SF_4 was investigated. The reaction of SF_4 with UO_3 to produce UF_6 may be used as a basis for a fuel-recovery process. Conversion of UO_2 to UO_3 by means of air and nitric acid vapor and also by means of oxygen and NO_2 was investigated between 350 and 500°C. Several aspects of the Direct Fluorination Process are being studied for the recovery of uranium from highly enriched U–Zr alloy fuels. Experiments incorporating a 2-zone reaction scheme for reacting Zr with HCl–HF gas mixtures were initiated. Laboratory data were obtained on reaction rates of Zircaloy-2 with various mixtures of HF and HCl at various temperatures. A series of fused salt dissolutions of synthetic Zr–U fuel assemblies was carried out in the graphite pilot plant dissolver according to a semicontinuous flowsheet. The conversion of UF_6 to UO_2 by direct reaction with steam and hydrogen is being investigated. The first phase of the experimental work in the 6-in. multistage fluid-bed reactor designed to achieve controlled downward transport of solids using external vibrators and without the use of internal downcomers was completed. Reactor Safety. The considerable inhibition of the burning propagation rates of uranium and zirconium by presence of small percentages of halogenated hydrocarbons in air was studied further. The study of ignition of metal powders has continued with studies of ignition of spherical zirconium powders. Preliminary ignition and burning propagation rate studies with plutonium binary alloy foils containing 2 at. % Al, Fe, C, Ni, Mn, and Cr were completed. The experimental program to determine rates of reaction of molten reactor fuel and cladding metals with water is continuing. Reactor Chemistry. Data are being obtained on the neutron-capture cross sections of U^{236} as a function of neutron energy. Corrosion studies are being made of various turbine constructional materials in alkaline permanganate procedure solutions. Several loop runs were made at 200 psig with irradiated uranium. Corrosion of the uranium pellets occurred within 25 to 30 hr. Construction work is proceeding on apparatus to study the effects of superheated steam on materials of construction. Analytical Research and Development. A fusion technique was developed for dissolution of PuO_2. Two analytical methods were developed for determination of plutonium. Routine Operations. The operation of the radioactive waste-processing facility and the γ-irradiation facility continued without incident. (For preceding period see ANL-6145.) (W.L.H.)

5852 (APRL-38-3.1) STATIC STRESS DETERMINATIONS IN SALT, SITE COWBOY. Robert H. Merrill (Bureau of Mines. Applied Physics Research Lab., College Park, Md.). July 29, 1960. 46p. Project COWBOY. Contract AT(29-2)-914. OTS.

An investigation was made to determine the stress field in the salt dome and the stress concentrations on the surface of the small (12-ft diameter) sphere. For the most part, the apparatus and techniques used in the investigation are new and have not been described in other reports. Therefore the theory, concepts, apparatus, and some of the lists made to determine the reproducibility of the apparatus are described briefly. (W.L.H.)

5853 (CF-60-9-119) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C PROGRESS REPORT [FOR] AUGUST–SEPTEMBER 1960. K. B. Brown (Oak Ridge National Lab., Tenn.). Dec. 29, 1960. 45p. OTS.

A chemical flowsheet is proposed for recovery of strontium and rare earths from Purex wastes. The iron in the waste is first complexed with tartrate and the pH is adjusted with caustic. Strontium and rare earths are extracted by a solvent comprised of di(2-ethylhexyl) phosphoric–sodium di(2-ethylhexyl) phosphate–tributyl phosphate–Amsco 125-82 and stripped with nitric acid. Processing the strip product through additional solvent extraction cycles yields isolated concentrated strontium and rare-earth fractions. In extraction of americium and rare earths from concentrated lithium chloride solution by tributyl phosphate(TBP) and by amines, aluminum chloride eliminated the need for added free acid. Hydrolytic precipitation was prevented by 1 to 2N $AlCl_3$ in 10N total chloride, and the extractions were higher and more reproducible than from 10N LiCl–0.1N HCl. Neither aluminum chloride nor calcium chloride could be used to replace the 10N LiCl completely. Much higher separation factors were obtained for americium over europium (85) and cerium (>100) by extraction from 10N chloride solution with 0.5M trilaurylamine than with TBP. The americium extraction coefficient was low, 0.4, but sufficient for use in a separation process. Preliminary tests indicated higher extraction of curium. An activity with a half life of about 175 days has been identified as isomeric with 6.7 days Lu^{177}. In completion of laboratory development of the process for recovery of technetium, neptunium, and uranium by tertiary amine extraction from uranium hexafluoride transfer cylinder wash solutions, re-extraction of technetium from the first-cycle product solution established a part of the extraction isotherm for further concentration and separation of technetium from nitrate in a second cycle. For control of the first-cycle nitrate separation step, a direct test with pH indicator solution successfully distinguished between <97, 97 to 99, and >99% hydrolysis of the amine nitrate. Estimates based on this close a control of hydrolysis, together with the separation factors found in the previously reported tests, indicate that a nitrate-removal section of perhaps only 12 ideal stages could be operated so as to produce an ammonium pertechnetate concentrate, essentially free from nitrate, as the single-cycle product. Nitrohydrocarbons, RNO_2, products of the reaction between hydrocarbon diluents and nitric acid, were previously identified as contributing to ineffective cleanup of TBP-Amsco 125-82 solutions. The testing has been extended to systems which have been exposed to γ-ray irradiation. Again, degradation products of the diluent were more detrimental to solvent cleanup than those coming from TBP. Parallel testing of the di(sec-butyl) phenylphosphonate-Solvesso 100-nitric acid system showed similar cleanup behavior patterns, demonstrating that the formation of nitrohydrocarbons occurs in diluents of widely varying nature, e.g., primarily aliphatic vs. primarily aromatic. The vapor pressures of a series of water-saturated solutions of tri-n-octylamine in benzene indicate that this system obeys Raoult's law (i.e., is apparently ideal) up to about 0.2M, in confirmation of the hypothesis used previously in deriving equilibrium constants for the system TOA–C_6H_6:H_2O–H_2SO_4. (auth)

5854 (IS-190) ANNUAL SUMMARY RESEARCH REPORT IN ENGINEERING FOR JULY 1, 1959–JUNE 30, 1960. (Ames Lab., Ames, Iowa). Aug. 1960. 41p. Contract W-7405-eng-82. OTS.

Work was continued on the determination of size and distribution of dispersed phase droplets in a pulse column. The droplet behavior and dispersed phase hold-up in York-mesh packing was studied with an equilibrated system of methyl isobutyl ketone and water with the ketone phase dispersed. An investigation is being made of the recovery of copper and EDTA from rare-earth ion exchange wastes. The effect of vapor properties on entrainment from bubble cap trays is being investigated. The design, construction, and operation of forced convection loops for circulating liquid metals are reported. The corrosion of 430 stainless steel and 2½% Cr–1% Mo steel by a liquid lead-bismuth eutectic is reported. The operation of a stainless-steel sodium-cooled liquid-metal condenser is described. The effect of ten additives, including V, Mg, Zr, and Ce in inhibiting the corrosion of stainless steel by lead-bismuth eutectic is being investigated. The current process for preparation of sodium ethyl sulfate is given. Single crystals of Zn, Sn, Pb, and AgCl were grown with a simple, low cost, Bridgman-type crystallizer. Tests were performed at 800 to 1000°C on Y, Nb, and Ta loops, circulating Th-Mg and U-Cr eutectics. Work on the development of electromagnetic pumps is reported. A new technique was developed for applying an impervious coating of glass to yttrium. (For preceding period see IS-16.) (W.L.H.)

5855 (NP-9394) ANNUAL REPORT FOR THE YEAR ENDED JUNE 30, 1960. D. J. Stevens (Australia. Commonwealth X-Ray and Radium Lab., Melbourne). Aug. 1960. 25p.

The organization and functions of the Laboratory are reviewed. Routine activities during the period are reported. (C.H.)

5856 (ORNL-1515(Del.)) AIRCRAFT NUCLEAR PROPULSION PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 10, 1953. W. B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Apr. 16, 1953. Decl. with deletions Dec. 14, 1959. 147p. Contract W-7405-eng-26. OTS.

The present status of the Aircraft Reactor Experiment No. 1 is discussed and illustrated by photos. Tests of valves, seals, pumps, etc., are described. Preliminary results with an ARE fuel-circuit mock-up are reported. The following studies on the Aircraft Reactor Experiment No. 2 (reflector moderated, circulating-fuel reactor) are reported: static physics of the reactor, including the effect on the reactor of core size and the use of various materials in the core and reflector; results of critical experiments; and mechanical design envisioned and developmental work initiated to provide a basis for the detailed design of a full-scale reactor. Research on fused-fluoride systems concerned with purifying and preparing ARE fuel and fuel carrier is reported. Corrosion characteristics of various fluoride mixtures are discussed. Metallurgy and ceramics research reported includes the fabrication of various reactor components for use at high temperatures; creep rupture tests of structural metals; development of special alloys, cermets, and ceramic coatings; and tests of welding and brazing alloys. The fabrication of control and safety rods are described. Physical property measurements of various fluoride mixtures and heat-transfer studies of experimental systems as well as aircraft components are presented. Chemical, petrographic, and x-ray-diffraction studies of impurities, corrosion products, and constituents of reactor fuels are reported. (W.L.H.)

5857 (UCRL-5704-T) INDUSTRIAL APPLICATIONS OF NUCLEAR EXPLOSIVES AND THEIR RELATION TO ENGINEERING GEOLOGY. Nanette Jaffe (California. Univ., Livermore. Lawrence Radiation Lab.) and Roland Carlson (Sandia Corp., Albuquerque, N. Mex.). Oct. 2, 1959. 44p. OTS.

Highlights of the various Plowshare proposals are discussed briefly in relation to engineering geology. These have been placed into four categories: the first discusses earth moving and includes harbor building and mining; the second discusses aquifers and ways in which underground water supplies can be improved with nuclear explosives; in the third part petroleum is discussed and includes oil shale and underground oil storage; and the last part is devoted to underground power and includes Project Gnome and improvement of geothermal sources. (W.L.H.)

5858 (UCRL-6068) SEISMIC DECOUPLING FOR EXPLOSIONS IN SPHERICAL CAVITIES. Final Report for Period December 1959–March 1960. William M. Adams and DeWitt C. Allen (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1960. 161p. Project COWBOY. OTS.

A series of paired explosions in a salt mine near Winnfield, La., was conducted to test a theory by A. L. Latter concerning seismic decoupling by underground cavities. The theory predicted a decoupling of 132. Free-field and surface measurements from an explosion in either a 6-ft- or a 15-ft-radius spherical cavity were compared with similar measurements from a completely tamped explosion of equal size. Shot sizes were from 20 lb up to a ton. Surface measurements were made out to 100 km and covered the frequency range from 0.05 to 100 cps. The experiment confirmed that decoupling does occur. For explosions that produce an average cavity pressure up to one-fifth and possibly more of the lithostatic overburden pressure, seismic waves were decoupled by more than 100, i.e., two orders of magnitude. Even for explosions producing an average cavity pressure of six times the lithostatic overburden pressure, the seismic waves were decoupled by 20–more than a full order of magnitude. Minimum decoupling factors as a function of frequency are presented. (auth)

5859 (AEC-tr-4208) WORKS [TRANSACTIONS] OF THE V. G. KHLOPIN RADIUM INSTITUTE. VOLUME VI. I. E. Starik, ed. Translation of Trudy Radievogo Inst. im. V. G. Khlopina 6, 1957. 176p. OTS.

The articles in this collection deal with radiochemistry and geochemistry. Some of the articles throw light on the geochemistry of radium-bearing water, on the problem of determining the age of minerals, and on other problems of radiochemistry and geochemistry that are of great scientific and practical importance. Separate abstracts were prepared for each article. (W.L.H.)

5860 NUMERICAL EVALUATION OF THE PSEUDO-TRIDENTS PRODUCTION CROSS-SECTION. C. Piron, M. Gailloud, Ph. Rosselet, and M. Biasutti (Laboratorie de Recherches Nucléaires, Lausanne, Switzerland). Helv. Phys. Acta 33, 945-52(1960). (In English)

The number of pseudo-tridents produced by conversion of Bremsstrahlung photons on the track of the primary particle was calculated for arbitrary experimental conditions and $E/mc^2 < 10^5$. The number was determined from the known radiation and materialization cross-sections, using the spatial distribution function of multiple Coulomb scattering given by Rossi. (B.O.G.)

5861 11th INTERNATIONAL NUCLEONICS BUYERS' GUIDE, 1960-61. Nucleonics 18, No. 11, 277-506(1960) Nov.

Listings of products, materials, and services are made in alphabetical order in an easy-to-use telephone-book style with the manufacturers of each product listed directly below. There are more than 200 cross references to distinguish synonyms and regional speech differences. In the manufacturers' index, following the company name, complete addresses of local sales offices with phone numbers are shown. (M.C.G.)

5862 COLLECTION OF POLISH PAPERS SUBMITTED TO THE SECOND UNITED NATIONS CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, SEPTEMBER 1958. Nukleonika Special Number, 1-144(1958). (In English)

The 16 Polish papers submitted to the Second United Nations Conference on the Peaceful Uses of Atomic Energy held in Geneva in September 1958 are given. The Polish nuclear-energy program, operation of nuclear power stations, energy levels of nuclei with mixed configurations, the chemistry of uranium in organic solvents, dissociation of plutonium complexes, reductometric determination of metals, and uranium leaching by the power sifting method are reported. Also discussed are fall-out measurements in Cracow, the effects of x rays on δ-aminolaevulic acid dehydrase, identification of organic sulfur compounds, vitamin B_{12} in bacteria, applications of radioisotopes, and deposition of radioactive cations on metals. (M.C.G.)

5863 PUBLIC DISCUSSIONS ON DISPOSAL OF RADIOACTIVE WASTES AND DEVELOPMENT OF NUCLEAR POWER. BULLETIN, SPECIAL NUMBER, NOVEMBER 1960. (International Atomic Energy Agency, Vienna). 24p.

The problems of radioactive waste disposal and the development of nuclear power were discussed by scientists of several countries. In Part I the disposal of low-level wastes in the sea and the amount of dilution obtained in this manner are discussed. The increased problems and costs that would be brought about by widespread use of nuclear power are summarized. In Part II the present technical status of nuclear power, the present costs, prospects for future reductions in costs, and applications in underdeveloped areas are reviewed. (M.C.G.)

BIOLOGY AND MEDICINE

General and Miscellaneous

5864 (A/AC.82/R.110) FACTORS WHICH INFLUENCE RADIATION RESPONSE. (United Nations. Secretariat). Nov. 21, 1960. 27p.

The effects of radiation in animals are dependent on many factors such as the nature of radiation, its dose and intensity, and the physiological state of the organism. The final outcome may also be influenced by factors which are deliberately introduced into the organism to modify the response. This last group of factors is discussed in detail. The radiation response may be modified either by preventing injury to the vital parts of the organism, or by supporting the recovery of the biological system affected. Prevention can be effected by supplying the cells with chemicals which interfere with, or limit the formation of free radicals or render the vital cell constituent less susceptible to interaction with the radical; in some cases, the protective chemical might even reverse actual damage, as, for instance, in the case of oxidized thiol groups. The main pharmacological characteristic of preventive chemicals is that they must be given prior to irradiation so as to be present in situ at the time of irradiation. Factors which support the recovery of irradiated organisms are basically biological units, cells, or tissues, which are introduced

after irradiation and which can replace the affected cells and tissues. The persistence time of the modifying factors in irradiated organisms may either be transient or permanent. Systematic studies on protective chemicals have been initiated as a consequence of Barron's demonstration, that sulfhydryl compounds are able to protect the enzyme systems in vitro. The first to employ a sulfhydryl compound for protection of animals was Patt, whose experiments were quickly followed by several groups of investigators. The number of compounds tested for their radiation protective effect is very large, and their nature quite varied. They are listed and brought up to date. 116 references. (auth)

5865 (BNL-608) PROTEIN STRUCTURE AND FUNCTION. REPORT OF SYMPOSIUM HELD JUNE 6-8, 1960. Brookhaven Symposia in Biology No. 13. (Brookhaven National Lab., Upton, N. Y.). 271p. OTS.

A symposium on protein structure and function was held at Brookhaven National Laboratory, Upton, N. Y., on June 6, 7, and 8, 1960. Topics discussed included intramolecular bonds in protein structure; the shape of proteins in solution; protein structure and enzyme action; the structure and function of heme protein; hormone structure and function; antibody structure and function; the structure of collagen; and the structure and function of virus proteins. (C.H.)

5866 (IEA-6) IMPROVED URINARY EXCRETION TEST FOR ASSAY OF VITAMIN B-12 TAGGED WITH COBALT-60. (Determinação de Vitamina B-12 Marcada com Co-60 em Urina). A. Abrão, Fausto W. Lima, and R. R. Pieroni (São Paulo, Brazil. Universidade. Instituto de Energia Atômica). [Nov.] 1958. 14p.

The various methods available to analyze vitamin B-12 tagged with Co^{60} are experimentally examined. A very simple and efficient method is proposed. The vitamin, present in urine or in aqueous solutions, is adsorbed by activated carbon; and the carbon is counted in a γ scintillometer. The techniques of the proposed method are described, and its advantages over classical methods of direct counting, precipitations, solvent extraction, and absorption in ionic resins are presented. (auth)

5867 (NP-9443) QUARTERLY PROGRESS REPORT NO. 37. (Chicago. Univ. Air Force Radiation Lab.). Oct. 15, 1960. 159p. Contract AF41(657)-252.

Nine separate research reports are presented. They are divided into 3 sections entitled: Effects of Ionizing Radiations on The Biochemistry of Mammalian Tissues, Influence of Exposure to Low Levels of Gamma and Fast Neutron Irradiation on The Life Span of Mice, and Pharmacological and Toxicological Compounds as Protective or Therapeutic Agents Against Radiation Injury in Experimental Animals. Separate abstracts have been prepared for each report. (T.R.H.)

5868 (NP-9443(p.11-20)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. II. THE EFFECTS OF VARIOUS CHEMICAL COMBINATIONS ON THE NITROGEN MUSTARD-INDUCED CHANGES IN ENZYME ACTIVITIES OF CERTAIN TISSUES OF RATS. Bernard E. Hietbrink, Ann B. Raymund, and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

Further studies are described on the ability of S-containing compounds to reduce the nitrogen-mustard (HN2) induced changes in enzyme activities of the spleen, thymus, and small intestine of rats. Several compounds were tested using adenosine triphosphatase (ATP) activity of spleen and thymus and acetylcholinesterase activity of small intestine. Cysteine was the most effective single agent in reducing damage to hematopoietic tissue. Dimethylammonium dimethyldithiocarbamate (DMDTC) and diethyldithiocarbamate (DEDTC) sodium markedly reduced the HN2-induced increase in ATP in the spleen and were the only combinations providing substantial protection in the intestine of animals given 5 mg/kg of HN2. Combining cysteine with 2-mercaptoethylamine (MEA) was ineffective. Glutathione (GSH) + aminoethylisothiuronium dichloride (AET) protected the spleen but not the thymus or intestine. DMDTC and DEDTC protected 90 and 80% against 4 mg/kg of HN2. Cysteine permitted 30% survival in rats with 7.5 mg/kg HN2. MEA and GSH protected 10% for 4 mg doses. Cysteine + MEA had an additive effect (60% survival for 7.5 mg dose). GSH did not improve cysteine but was more than additive with DMDTC. GSH + DEDTC protected 80% against a 4 mg dose. (T.R.H.)

5869 (NP-9443(p.32-7)) THE EFFECTS OF IONIZING RADIATION ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. IV. EFFECTS OF MERCAPTOETHYLAMINE AND DITHIOCARBAMATES ON ENZYMES OF INTERMEDIARY CARBOHYDRATE METABOLISM. Kenneth P. DuBois and Ann B. Raymund (Chicago. Univ. Air Force Radiation Lab.).

A study was made to see if mercaptoethylamine (MEA) resembles aminoethylisothiuronium (AET) and the dithiocarbamates in its effect on enzyme systems. Measurements of the effect of MEA showed that 10^{-2} M concentrations were required for inhibition of oxidation of α-ketoglutaric acid and pyruvate plus fumarate by rat liver and kidney. Pyruvate oxidation was 50% inhibited by 1.8×10^{-3} M MEA. The succinic dehydrogenase activity of liver and spleen of rats was 50% inhibited by 4×10^{-3} M and 6×10^{-3} M MEA, respectively. Cytochrome oxidase activity was not appreciably affected by MEA. (T.R.H.)

5870 (NP-9443(p.53-68)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF MICE. I. CHEMICAL PROTECTION AGAINST CHRONIC RADIATION INJURY. J. Doull, V. Plzak, and M. Root (Chicago. Univ. Air Force Radiation Lab.).

A study was made of the radioprotective effects of 2-aminoethylisothiuronium(I), 2-mercaptoethylamine(II), serotonin(III), p-aminopropiophenone(IV), hydroxyacetonitrile(V), and dimethyldithiocarbamic acid(VI) in mice exposed to fractional doses of 1,000 and 2,000 r of whole-body x irradiation. Doses previously shown to produce marked protective effects were ineffective for II, IV, and V and only slightly effective for I. There was a significant reduction in 30-day mortality for III and VI given prior to each exposure, but the effect was less for acute exposures of the same RBE. The development of tolerance does not adequately explain the reduced effectiveness at least for II. (T.R.H.)

5871 (NP-9443(p.85-114)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. I. THE INFLUENCE OF VARIOUS CHEMICAL COMPOUNDS ON RADIATION LETHALITY IN MICE. Vivian Plzak, Stanley Brois, and John Doull (Chicago. Univ. Air Force Radiation Lab.).

An evaluation was made of the protective activity of 69 compounds against radiation lethality in mice. Toxicity was determined, and protective effects at 2 dose levels were

studied against 800 r whole-body irradiation survival at 30 days. Of the compounds tested, 11 allowed some survival; 4 of the 11 were dithiooxamides. (T.R.H.)

5872 (NP-9443(p.115-57)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. II. ACID-CATALYZED REACTIONS OF AZIRIDINES WITH THIOUREA AND ITS DERIVATIVES. Stanley J. Brois and Gerhard L. Closs (Chicago. Univ. Air Force Radiation Lab.).

Reaction rates of thiourea with 10 aziridines were measured at 18.16°C by a spectrophotometric technique. Activation parameters were calculated and discussed. Product analysis studies in connection with rate studies on 3 unsymmetrical imines were done using reductive desulfurization and gas chromatography. (T.R.H.)

5873 (NYO-9309) EXTERNAL LOCALIZATION IN ORGANS OTHER THAN THE BRAIN BY MEANS OF POSITRON-EMITTING ISOTOPES. Final Report [for] Period Covered: July 1, 1956–December 31, 1959. Gordon L. Brownell, Saul Aronow, and William V. McDermott ([Massachusetts. General Hospital, Boston]). 16p. Contract AT (30-1)-1962. OTS.

Research is reported on the extension of positron scanning to organs other than the brain for diagnostic applications. A scanning instrument for this purpose was designed and constructed and tested on normal and abnormal patients. Scanning is automatic over an area 18-in. by 24-in. The detecting heads are a pair of 8-in.-dia. steel tubes with multiple crystal detectors as well as a crystal for single-channel scanning. The tests show that the device is extremely reliable and adaptable. (T.R.H.)

5874 (ORO-310) SEMI-ANNUAL PROGRESS REPORT FOR JANUARY 1, 1960–JUNE 30, 1960. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.). Nov. 1960. 74p. Contract AT-40-1-GEN-242. OTS.

Progress is reported in the following studies: factors affecting dwarfism and the inheritance of this trait in beef cattle; the effects of magnesium deficiency on Mg^{28} metabolism in sheep; the effect of excessive dietary calcium on the uptake of Se^{75}, Mo^{99}, Cu^{64}, and Fe^{59} in swine; tracer studies on the binding sites of calcium and strontium in swine; tracer studies on cesium and potassium metabolism in lactating dairy cows; an ultrafiltration study on stable and radioactive calcium and phosphorus levels in milk and blood plasma in lactating cows; the influence of dietary calcium, phosphorus, and magnesium on the body weight and uptake of Ca^{45}, P^{32}, and Sr^{89} by the tibiae of chicks; the distribution of Ca^{45}, Sr^{89}, and Ba^{133} in the eggs and various protein fractions of hens; the binding of Mo^{99} by proteins in plasma, liver, and kidney of chicks; the effects of radiation on the reproductive physiology in rats, observations on the physical state of burros exposed to combined neutron and γ irradiation or to γ radiation or neutron irradiation alone; the status of swine surviving combined γ-neutron irradiation from atomic detonations; the physical condition and determination of $LD_{50/30}$ values for irradiated adult female Hereford cattle; the physical condition of cattle exposed to radioactive fall-out from the first atomic test at Alamogordo, New Mexico, July 16, 1945; the survival and physical condition of calves exposed to 550 r total-body Co^{60} γ radiation with supportive therapy; investigations of the physiological effects of radiation in domestic animals; the radiosensitivity of seeds; the effects of pre and postradiation humidity and species on the radiosensitivity of seeds; the transmission of radiation-induced mutations in plants; factors affecting the diffusion of P^{42}, Ca^{47}, and Sr^{85} in soils; and the development of a procedure for bone-density measurements. (C.H.)

5875 (TID-7591) FIFTH ANNUAL MEETING OF THE BIO-ASSAY AND ANALYTICAL CHEMISTRY GROUP, GATLINBURG, TENNESSEE, OCTOBER 1-2, 1959. (Oak Ridge National Lab., Tenn.). Nov. 1960. 109p. OTS.

Separate abstracts were prepared for 10 papers presented at this meeting. (C.H.)

5876 (TID-11062) THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS. [Period covered] October 1, 1959–October 1, 1960. Bruce Wallace (New York State Coll. of Agriculture, Ithaca). Oct. 31, 1960. 30p. Contract AT(30-1)-2139. OTS.

A discussion is presented of the results of three experiments on the viability effects of newly induced mutations. Two of these experiments deal with the X-chromosome of Drosophila melanogaster. In brief, males that carry irradiated X-chromosomes have lower viabilities than males with nonirradiated chromosomes. This is true at all levels of radiation used: 500, 1000, and 2000 r. Females carrying a single irradiated chromosome are affected only slightly, if at all, by mutations on this chromosome. If all six tests listed in Tables 2 and 3, which involve nearly 750,000 individuals, are averaged, the observed frequency of control and "x-ray" females, a measure of their relative viabilities, is identical (54.4%). The third experiment is a more complex study of second-chromosome viability mutations. This experiment is designed to test chromosomes of different geographic origin, different combinations of these chromosomes (homozygous, intra and interpopulation heterozygous combinations) and four levels of x radiation (including 0 r, the control). Summarized data, although extensive, only permit a conclusion to be drawn that expectations based on the gross manipulation of chromosomes in the mating scheme are fulfilled and that homozygous and intrapopulation heterozygous combinations seem to react differently to the presence of newly induced mutations. The results of the interpopulation combinations (wild-type and CyL/+) do not seem to agree with each other or with predictions based on any simple model of population genetics. (auth)

5877 (TID-11069) PROGRESS REPORT NO. XX [FOR] MAY 1, 1960–OCTOBER 31, 1960. (New England Deaconess Hospital, Boston). 50p. Contract AT(30-1)-901. OTS.

Biological Chemistry. Progress is reported on the control lesion in scurvy and phenylketonuria induced in rats. Biophysics and Radiation Protection. Brief reports are given of equipment fabrication, instrument design, irradiations, and x-irradiation studies. Biostatistics and Administration. Progress is reported in statistical studies of radiation exposure and effects in dentists. Experimental Pathology. Research reports are presented from studies related to human cancer implants, acute radiation effects, parabiotic rats, elastic tissue, ultraviolet microscopy, animal form, chronic whole-body radiation effects, and effects of connective tissue on metastasis. Hematology. Experimental findings related to etiology and morphologic modifications of lymphocytes with "atypical nuclei" that become plasma cells are reported. Radiobiology. A thyroid-stimulating hormone assay was sought, and the role of TSH was studied. X-Ray Diffraction. Work is reported on ion exchange of strontium in bone and on the crystal structure of magnesium diethyl phosphate. (T.R.H.)

5878 (TID-11330) ACTION OF TRITIATED TETANUS TOXIN AND TOXOID UPON THE NERVOUS SYSTEM AND UPON THE ANTIBODY FORMING MECHANISM. Period covered: April 1, 1959–March 31, 1961. Robert S. Speirs (New York. State Univ., Albany. Research Foundation). Dec. 27, 1960. 16p. Contract AT(30-1)-2414. OTS.

Progress is reported in studies on the action of tritiated tetanus toxin and toxoid upon the nervous system and upon the antibody forming mechanisms in mice. Procedures are described for the preparation of purified tritiated tetanus toxin. The tritiated toxin was injected into mice immunized to tetanus toxoid. Distinct differences were noted in the cellular reaction to the tritiated antigen in immunized and control animals. The data suggest that antibody-producing cells contain antigen at the time antibody is being produced. A quantitative procedure was developed for determining the number of cells responding during an inflammation. Procedures were developed for the automatic processing of radioautograms. (C.H.)

5879 (UCRL-9208(p.84-7)) SEARCH FOR UNSTABLE FIXATION PRODUCT IN ALGAE BY METHYLATION. Zofia Kasprzyk (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a search for unstable fixation products in photosynthetic products of algae. The methylation of the products of photosynthesis and the preparation of phosgene are described. Carbomethoxychloride was prepared by the action of methyl alcohol on phosgene. Using radioactive carbon tetrachloride for the preparation of carbomethoxychloride, carbomethoxybiotin labeled in the carboxyl group was prepared. Starting with radioactive methanol, the label was in the methyl group. The products of photosynthesis of Chlorella were analyzed by paper chromatographic methods. Results are described. (C.H.)

5880 (UCRL-9208(p.88-111)) EFFECT OF METHANOL ON THE DISTRIBUTION OF EARLY PRODUCTS OF $C^{14}O_2$ FIXATION. Zofia Kasprzyk (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from an investigation of the effect of methanol on the distribution of early products of $C^{14}O_2$ fixation by Scenedesmus. The effect of methanol on algae adapted to a mixture of CO_2 and hydrogen was also investigated. Data are tabulated. (C.H.)

5881 (UCRL-9208(p.114-22)) FURTHER STUDIES ON STERILITY PRODUCED IN MALE MICE BY DEUTERIUM OXIDE. Ann M. Hughes and Edward L. Bennett (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a study of the effect of 30% D_2O in drinking water on the fertility of male mice. Data are tabulated. (C.H.)

5882 (UCRL-9208(p.123-4)) FURTHER STUDIES ON THE EFFECTS OF D_2O ON DROSOPHILA MELANOGASTER. Ann M. Hughes (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a study of the genetic effects of D_2O in the media in which Drosophila were grown. (C.H.)

5883 (UCRL-9440) THE ORIGIN OF LIFE ON EARTH AND ELSEWHERE. [PART] II. Melvin Calvin (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 19, 1960. 42p. Contract W-7405-eng-48. OTS.

The synthesis of relatively complex organic molecules by ionizing and radical mechanisms (induced by high-energy radiations, ultraviolet, and electric discharge) from methane, ammonia, water, and hydrogen is described, both theoretically and experimentally. It is shown that the molecules which tend to be formed under such random conditions are the very ones which today are the common building blocks in the biological reconstruction of organic material. Such molecules are the amino acids, the simple carboxylic and hydroxy acids, purines, pyrimidines, etc. The appearance of order among such random molecules is induced by two forces, namely, autocatalysis and crystallization. The latter is particularly important in the appearance of highly efficient macromolecular structures and arrangements which are so characteristic of present-day living organisms. Points of contact of these theories with experiment are indicated, and where confirmation has been obtained it is described. The areas of ignorance, requiring further experimentation, are defined. A first step in a possible test of these prebiotic organic syntheses on other astral bodies has been made by examining the organic material found in meteorites. The nature of the structures appearing therein is indicated. (auth)

5884 (USNRDL-TR-473) PASSIVE TRANSFER OF BONE MARROW HOMOTRANSPLANTATION IMMUNITY WITH SPECIFIC ANTISERA. R. M. Garver and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Sept. 18, 1960. 16p.

The intraperitoneal injection of specific antisera (anti-C_3H mouse spleen cells) prevented the protective effect of C_3H strain bone marrow (i.e., homologous) injected intravenously into lethally x-irradiated $(LxA)_1$ hybrid mice. When this antiserum was absorbed in vitro with packed C_3H erythrocytes (washed free of leukocytes), no loss of antibone marrow activity of the antiserum could be observed. Injection of anti-C_3H erythrocyte serum did not prevent "takes" of C_3H bone marrow. Anti-LAF_1 spleen serum (prepared in A mice) had no deleterious effect on protection by bone marrow when LAF_1 bone marrow (i.e., isologous) was administered to lethally irradiated LAF_1 host mice. In this instance, it is considered that the isoantibodies are absorbed out by the host tissue isoantigens, permitting little if any antibody to reach the injected marrow cells. Following in vitro incubation of isologous or homologous marrow cells with specific antisera, the protective effect of the marrow was diminished greatly. The question of cells versus antibody in the homograft reaction was discussed. It is concluded that dissociated cell homografts (such as bone marrow cells) can be rejected by humoral isoantibodies per se. (auth)

5885 THE COLLECTION AND STORAGE OF VIABLE HUMAN FETAL HEMATOPOIETIC TISSUE FOR INTRAVENOUS USE. Joseph W. Ferrebee, Harry L. Lochte, Jr., Herbert Swanberg, and E. Donnall Thomas (Mary Imogene Bassett Hospital, Cooperstown, N. Y. and Children's Medical Center, Boston). Blood 14, 1173-9(1959) Nov.

Livers and spleens from human fetuses in the 12 to 20 weeks' gestation period were preserved in a sterile condition in glycerol and serum at −70°C for periods of several weeks. Studies of DNA synthesis rates with C^{14}-formate, and radioautographs after incubation with tritiated thymidine, revealed that hematopoietic elements concentrated in these tissues at this stage of gestation maintained their viability during these periods of storage. Intravenous infusion of cellular suspensions prepared from stored frozen tissue, or from fresh tissue in this same age group, produced no observed untoward clinical event in the three patients studied. Some of the arguments favoring the use of fetal hematopoietic tissue, in contrast to adult marrow, in the attempt to restore marrow function after radiation injury are briefly reviewed. (auth)

5886 THE EFFECTS OF THYROID AND PARATHYROID DEFICIENCY ON REPRODUCTION IN THE RAT. Marshall W. Parrott, Muriel E. Johnston, and Patricia W. Durbin (Univ. of California, Berkeley). Endocrinology 67, 467-83(1960) Oct. (UCRL-8969)

Sexually mature female rats were made thyroid-deficient by surgery or by irradiation of the thyroid gland with I^{131} or At^{211}. Thyroid hormone was replaced with desiccated thyroid, L-thyroxine, or L-triiodothyronine. Supplemental calcium was given orally as calcium gluconate. Animals were mated to test reproductive capacity 2 to 3 months after thyroid removal thus assuring complete elimination of residual thyroid hormone. Thyroid-deficient rats had smaller litters and fewer pregnancies, only 31% compared to normal, 79% pregnancies. All three forms of thyroid hormone supplement increased the number of conceptions to 84%, and litter sizes were within control limits. Stillbirths, prolonged gestation, and maternal tetany were common in I^{131}-treated groups as well as in surgically thyroparathyroidectomized rats regardless of whether or not supplemental thyroid hormone was given. In 46% of the cases tested the serum calcium level of I^{131}-treated, thyroxine-supported rats was less than 6 mg% at parturition, whereas the average serum calcium of normal controls was 10.5 mg%. Variable radiation damage to the parathyroid glands of I^{131}-treated animals was observed histologically. There was a rough correlation between the extent of structural parathyroid damage and a lower than normal serum calcium level. Thyroid hormone was shown to be essential for normal fertility and pregnancy, but its role in parturition, if any, could not be demonstrated. The difficult labor observed in the I^{131}-treated rats was considered to be due to parathyroid deficiency. (auth)

5887 STRAHLENSCHUTZ IN KLINIK UND ÄRZTLICHER PRAXIS. (Radiation Protection in Clinic and Medical Practice). Werner Lorenz. Archiv und Atlas der Normalen und Pathologischen Anatomie in Typischen Röntgenbildern. Band 88. (Archive and Atlas of Normal and Pathological Anatomy in Typical X-Ray Pictures. Volume 88). Stuttgart, Georg Thieme Verlag, 1961. 266p. DM 66. $15.70 (New York, Intercontinental Medical Book Corporation).

An extensive treatment of radioprotective equipment, procedures, and regulations for medical use of x-ray equipment and other radiation sources is presented. The chapters are entitled: Responsibilities and New Obligations of the Physician; International Conventions, Laws, Legal Codes, Rules, and Recommendations; Radiation Protection in Construction; Radiation Protection in Apparatus Design; Work Protection for Medically-Employed Radiation Exposed Persons; Radiation Protection of Patients; Explanation and Care Duties; Most Important Protective Measures for Diminishing Injury in Existing Radiation Reactions; and Radiation Protection of the "Disinterested Third Party" in Medical Use of Ionizing Radiation. (T.R.H.)

Biochemistry, Nutrition, and Toxicology

5888 (NP-9443(p.21-31)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. III. STUDIES ON THE TOXICITY OF RARE EARTH COMPOUNDS AND THEIR INFLUENCE ON RADIATION LETHALITY. David W. Bruce, Bernard E. Hietbrink, and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

The approximate LD_{50} values for rare earth nitrates of didymium, Pr, Nd, Sm, Eu, Gd, Tb, Ho, Er, and Yb are given. They show that the metals are all of the same relative toxicity, along with Ce, Lu, and Tl. The LD_{50} for oral doses were: didymium 4100, Ce 4200, Pr 3500, Nd 2750, Sm 2900, Dy 3100, Ho 3000, and Yb 3100 mg. Eu, Gd, and Tb were greater than 5000 mg. Gadolinium and Lu nitrates had LD_{50} of 300 mg/kg and 290 mg/kg intraperitoneally. Preliminary mortality studies showed that rare earth injections with 700 r of x rays gave a higher mortality than either treatment alone. (T.R.H.)

5889 (UCRL-9208(p.125-35)) INVESTIGATION OF POSSIBLE BIOCHEMICAL DIFFERENCES CORRELATED WITH ETHANOL PREFERENCE IN MICE. Edward L. Bennett and Marie Hebert (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a study of the metabolism of ethanol in several strains of mice. (C.H.)

5890 THE USE OF BLOOD SUBSTITUTES IN POLONIUM AFFECTION. Preliminary Report. Yu. V. Vissonov. Med. Radiol. 5, No. 10, 35-8(1960) Oct. (In Russian)

A study was made of the effect of two blood substitutes—"BK-8" and "TSOLIPK-4a." "BK-8" exerts a positive effect when the organism is affected with low doses of polonium. The "TSOLIPK-4a" solution produced no essential influence on the course of polonium affection, although the manifestations of the hemorrhagic syndrome were marked to a lesser degree. (auth)

Fallout and Ecology

5891 (UCRL-Trans-626) BIOSYNTHESIS AND DEGRADATION OF NICOTINE. Kazimierz Toczko. Translated from Postepy Biochem. No. 6, 43-58(1960). 17p.

Isolated root cultures of tobacco were fed with compounds labeled with C^{14}. Chemical transformations involved in the biosynthesis and degradation of nicotine were studied. Reaction mechanisms are discussed. Results are compared with those previously reported. (C.H.)

5892 THE INFLUENCE OF EARTHWORMS (LUMBRICIDAE) AND OF WIREWORMS (ELATERIDAE) ON THE INCORPORATION OF RADIOACTIVE ISOTOPES Ca^{45} AND Sr^{90} BY PLANTS FROM THE SOIL. A. A. Peredel'skiĭ, I. O. Bogatyrev, and N. S. Karavyanskiĭ (Inst. of Biological Physics, Academy of Sciences, USSR and William's All-Union Inst. of Scientific Research in Fodder, [USSR]). Doklady Akad. Nauk S.S.S.R. 134, 1450-2(1960) Oct. 21. (In Russian)

The influence of rain-worms (lumbricidae) and click beetle (elateridae) larva on corn and Windsor bean (vicia faba), uptake of Ca^{45} and Sr^{90} was investigated. The activity of contaminated ground for corn was 0.1 $\mu c/g$ of Ca^{45} and 0.0064 $\mu c/g$ of Sr^{90} and for beans 0.05 $\mu c/g$ Ca^{45} and 0.01 $\mu c/g$ Sr^{90}. Tabulated results indicate increased concentrations of Ca^{45} and Sr^{90} in corn leaves in the presence of elateridae and in most cases in the presence of the lumbricidae. However, the influence of elateridae is considerably stronger. The presence of elateridae and lumbricidae depresses the uptake of Sr^{90} and Ca^{45} by corn roots. In contrast, the influence of lumbricidae on the uptake of isotopes by bean leaves is much stronger than the elateridae, while lumbricidae exhibits stronger depressive effects on Ca^{45}

and Sr^{90} uptake by bean roots. The lumbricidae exert a stronger influence on plants' assimilation of radioactive isotopes. (R.V.J.)

5893 THE ENTRANCE INTO PLANTS AND ACCUMULATION IN THE YIELD OF SOME RADIOACTIVE PRODUCTS OF DIVISION. I. V. Gulyakin and E. V. Yudintseva (Order of Lenin Agricultural Academy, Moscow). Izvest. Akad. Nauk S.S.S.R., Ser. Biol. No. 6, 874-85(1960) Nov.-Dec. (In Russian)

Radioactive fission products may accumulate in plants in higher concentrations than are contained in an external medium. Sr^{90} has the highest ability to concentrate in the yield of agricultural plants because 80 to 90% of strontium entering the plants moves into the overground organs. Furthermore the radiostrontium being in the soil in a more mobile state than other fission products may enter the plants intensively. The plants accumulate the radiostrontium from water solutions approximately 100 times as much as from the soil, depending on its properties and peculiarities of plants, by 5 to 10 times higher than its concentration in an external medium. Under certain conditions the Cs^{137} content in plants may also reach considerable values. On entering through leaves, cesium moves intensively into other organs and a considerable amount of cesium may accumulate in the yield, in particular, in the reproductive organs of the plant. The radioactive fission products, in particular strontium and cesium, enter the plants from light soils most intensively while their entrance from heavy soils is considerably less. On light soils some plants may absorb a great amount of Sr^{90} reducing its content in the soil. The chalking of acid soils and the application of organic substances reduces the fission products entering into plants and their accumulation in the yield, especially on light soils. The cesium and strontium content in the yield of plants is decreased when numerous fertilizers and dung are systematically applied. The most essential lowering in accumulation of fission products in agricultural plants is observed when these plants are deeply imbedded in the soil. (auth)

5894 AN APPARENT DIFFERENCE IN THE RENAL CLEARANCE OF CALCIUM-45 AND CALCIUM-40 IN RATS. Robert C. Likins and Doris L. Craven (Inst. of Dental Research, Bethesda, Md.). Nature 188, 592-3(1960) Nov. 12.

In investigating the comparative excretion of Ca^{45} and Sr^{89} in rats, evidence of unexpected variability in the renal clearance of Ca^{45} and Ca^{40} was found. Weanling female Sprague-Dawley rats (I) were injected intraperitoneally with 1.0 ml of a solution containing carrier-free Sr^{89}, Ca^{45}, and 0.05 mg of calcium. Urine samples were collected at 30 and 60 min following injection and analyzed for Sr^{89}, Ca^{45}, and total calcium. One hour after injection, a blood sample was taken and analyzed for the Sr^{89} and Ca^{45} concentration in the plasma. A comparable group of rats (II) were denied food for 12 hr and the tests were repeated. The results of the tests on the two groups of six and eight rats, respectively, are tabulated. (B.O.G.)

5895 INCORPORATION OF CAESIUM-137 FROM NUCLEAR DEBRIS INTO THE BIOSPHERE. H. F. van Wijk (Physical Chemistry Inst., T.N.O., Utrecht) and R. Braams. Nature 188, 952-3(1960) Dec. 10.

The possibility of Cs^{137} uptake by man via the soil was studied by conducting transport and assimilation experiments on contaminated soil. When Cs^{137} is present on top of a compact clay layer, it remains there in spite of water precipitation, and when it is present on top of crumbled clay over a compact layer, it is washed down by water only as far as the compact layer. In sedimentation experiments, ~50% of Cs^{137} in pH 7.5 clay was adsorbed on particles smaller than 2 μ and representing only 5% of the total clay mass. In pH 7.2 sand, >70% of the Cs^{137} was found on only 2% of the total mass. When clay and sand containing Cs^{137} were shaken for 4 hr with acetate buffer, only 2 and 5%, respectively, of Cs^{137} went into solution, and grass grown on clay or sand containing Cs^{137} assimilated only a few tenths of 1% of the Cs^{137} over a period of several months. Thoroughly washed grass held for 15 min in dilute Cs^{137} solutions was found to fix ~30% of the Cs^{137}, confirming the assumption that the main route of biosphere contamination is by foliar absorption. However, soil could become an important source of Cs^{137} under certain conditions, e.g., prolonged drought or low Cs^{137} activity in rain water, because the cow ingests soil along with grass and its omasum has a pH of 2 to 3, low enough to dissolve ~20% of the Cs^{137} in ½ hr. (D.L.C.)

5896 PACKAGED ORGANIC MATERIALS AS MONITORING TOOLS FOR RADIONUCLIDES. Louis G. Williams, Michael Howell, and Conrad P. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). Science 132, 1554-5(1960) Nov. 25.

Pint-size perforated polyethylene bags were used as containers to test preserved tea, spinach, ion-exchange resin, live filamentous green algae, and dead filamentous green algae for the sorption and concentration of radionuclides from natural aquatic habitats and from a variety of laboratory controlled nutrient media. These packaged materials were used to detect trace levels of radionuclides not found by the usual methods of analysis of the raw water itself for dissolved radionuclides. (auth)

Radiation Effects on Living Tissues

5897 (NP-9443(p.1-10)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. THE EFFECTS OF CYSTEINE AND 2-MERCAPTOETHYLAMINE ON THE RADIATION-INDUCED CHANGES IN ENZYME ACTIVITIES IN CERTAIN RAT TISSUES. Bernard E. Hietbrink, Ann B. Raymund, and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

A study was made comparing the effects of cysteine and 2-mercaptoethylamine on the adenosine triphosphatases and cholinesterase activities of rat tissues three days after administration of single doses of 100 to 500 r. A similar comparison was made in animals treated with these agents before daily x-ray doses of 100 r and assayed one day after accumulated doses of 300, 500, and 700 r. Cysteine and MEA enhanced the damaging effects on the spleen for 100 r doses but protected against doses of 200 to 500 r. The combination was more effective than either agent alone. Considerable protection was provided against the effects of 400 r to the thymus, but no protection was afforded in lower doses. Pretreatment with these agents diminished the radioinduced decrease in cholinesterase activity of the intestine. Daily injections reduced the increase in enzyme activity in accumulated doses of 300 and 500 r, but did not protect the thymus. (T.R.H.)

5898 (NP-9443(p.38-52)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. V. THE INFLUENCE OF X-IRRADIATION ON THE HYDROLYSIS OF ADENOSINE TRIPHOSPHATE AND OTHER NUCLEOTIDES. Kenneth P.

DuBois, Ann B. Raymund, and Bernard E. Hietbrink (Chicago. Univ. Air Force Radiation Lab.).

A comparison was made of the rates of hydrolysis of several nucleotide triphosphates by spleen and thymus homogenates of normal and irradiated rats. With normal rat spleen the rate for inosine triphosphate, cytidine triphosphate, and uridine triphosphate was 50% greater than for adenosine triphosphate and guanosine triphosphate. With normal thymus homogenates the inosine and cytidine were more rapidly hydrolyzed than adenosine, guanosine, and uridine, which were all approximately equal. Single doses of 50 to 400 r caused dose-dependent increases in the rate of hydrolysis of inosine triphosphate by spleen and thymus. This substrate thus serves as a sensitive indicator of radioinduced changes in pyrophosphatase activity. Calcium and magnesium were equally effective as activators. Hypophysectomy and treatment with propylthiouracil had no effect on the radioinduced increase in ATP activity indicating that it is not a result of thyroid or pituitary stimulation. (T.R.H.)

5899 (NP-9443(p.69-84)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF MICE. II. FURTHER STUDIES USING THE DAILY RADIATION TO DEATH PROCEDURE FOR EVALUATING LIFE SPAN SHORTENING IN MICE. J. Doull, V. Plzak, M. Root, and J. Cowan (Chicago. Univ. Air Force Radiation Lab.).

Mice exposed to whole-body γ irradiation, allowed to recover 4 weeks, and then given daily irradiation to death exhibit decreased median survival times linearly related to the initial dose (0 to 1000 rep). Serotonin, 2-aminoethylisothiuronium, and p-aminopropiophenone administered prior to the initial irradiation did not prevent lifespan shortening. Administration 4 weeks prior to chronic irradiation significantly decreased ability to withstand chronic irradiation. Fractionation of exposures and protraction over periods of 10 to 40 days increases the LD_{50} linearly. (T.R.H.)

5900 (ORO-351) THE GENETIC AND DEVELOPMENTAL EFFECTS OF INGESTED RADIOACTIVES. Annual Progress Report [for] 1959. Daniel S. Grosch (North Carolina State Coll., Raleigh). 13p. Contract AT (40-1)-1314. OTS.

Progress is reported in studies of the quantitative aspects of temporary and permanent sterility induced in the wasp Habrobracon by external irradiation and by ingested inorganic compounds. Results indicate that induced dominant lethals form the basis of reduced fecundity and fertility. In combination with radiation, slight effects on fecundity were observed when strontium was fed. Significant increases in radiation damage was seen when cations that in themselves influence gamete production and survival were fed. Data are tabulated on the effect of a single feeding of nickel sulfate on the fecundity pattern. The effects of enzyme activating metals and thiol reagents on fecundity were also studied. Inorganic compounds used in ingestion experiments are tabulated. (C.H.)

5901 (TID-11043) THE EFFECT OF NEUTRONS AND OTHER RADIATIONS ON OCULAR LENS. Progress Report [for] January 1960–December 1960. V. Everett Kinsey (Kresge Eye Inst., Detroit). 18p. OTS.

In the belief that cataract is primarily caused by deranged protein chemistry in the lens, studies were continued of turnover rates of amino acids in lenses. Specifically, turnover rates and amino acid compositions were measured for the epithelial capsular part, cortex, nucleus, and posterior capsule. Studies were also made of glucose transport, fructose metabolism, and lenses of diabetic animals. (T.R.H.)

5902 (JPRS-7264) BLASTOMOGENIC ACTION OF IONIZING RADIATION. RADIATION TUMORS OF ANIMALS. N. A. Kraievskiĭ (Krayevskiy) and N. N. Litvinov. Translated from Arkh. Patol. 22, No. 8, 3-17(1960). 43p. OTS.

Results are reported from an investigation of pretumerous changes in organs and tissues exposed to ionizing radiations. The influence of factors such as trauma, inflammation, and pregnancy on the development of radiation tumors was studied. The role of the nervous system and the functional state of the glands of internal secretion were also studied. Data are tabulated on the relation between the amount of energy absorbed and the tumorogenic effects. (C.H.)

5903 (JPRS-7269) EFFECT OF X-RAY IRRADIATION ON THE FORMATION OF ENZYMES IN THE PANCREAS. (O Vliyanii Rentgenovskogo Oblucheniya na Vyrabotku Fermentov Podzheludochnoy Zhelezy). V. V. Nikol'skiĭ (Nikol'skiy) and G. V. Rubtsova. Translated from Voprosy Med. Khim. 6, 365-7(1960). 7p. OTS.

During the first month following irradiation in the region of the fistula formed after an operation for a pancreatic cyst, the trypsin activity in the secreted fluid decreased 17-fold; and the amylase activity decreased two-fold. A drastic decrease in lipase activity was observed during the subsequent periods. The fistula was closed within five months after irradiation. (auth)

5904 (NP-tr-523) THE EFFECT OF INTRACELLULAR HAEMIN ENZYMES ON THE RADIATION INACTIVATION OF BACTERIA. T. Houtermans, J. Jensen, and E. Thofern. Translated by J. B. Sykes (U.K.A.E.A. Atomic Energy Research Establishment) from Z. Naturforsch. 12b, 437-40(1957). 15p. (Handwritten MS. Copy). JCL.

Results are reported from a study of the effects of catalase and cytochromes on the inactivation of a heminheterotrophic variant of micrococcus pyrogens by ultraviolet, alpha, or x radiation. (C.H.)

5905 (NP-tr-533) ON THE METHODS OF FINDING CHANGES ARISING IN THE ORGANISM UNDER THE INFLUENCE OF SMALL DOSES OF IONIZING RADIATION. Translation of USSR report A/AC.82/G/R-37. Oct. 26, 1956. 9p.

Changes induced by small doses of ionizing radiation develop slowly and are not manifest in distinct clinical symptoms. Indices are presented for determining the characteristics of small radiation effects. The symptoms of functional disturbances that are characteristic of the early changes in the activities of the central nervous system are described. (C.H.)

5906 HOMOGRAFTS OF BONE MARROW IN DOGS AFTER LETHAL TOTAL-BODY RADIATION. E. Donnall Thomas, Charles A. Ashley, Harry L. Lochte, Jr., Alfred Jaretzki, III, Otto D. Sahler, and Joseph W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Blood 14, 720-36(1959) June.

Twenty-two dogs (20 males and two females) were uniformly exposed over their entire surfaces to supralethal irradiation: 800 to 1200 r of 250 kv x rays measured in air at mid-body position. On the third day and after the last exposure, these irradiated animals were given infusions of normal bone marrow. The marrow for their infusions was taken from female litter-mates, from mothers or from unrelated dogs. Evidence for a return of marrow function and for a successful marrow graft was evaluated

on the basis of the reappearance of formed elements: platelets, leukocytes, and reticulocytes, in the peripheral circulation; the appearance in males of leukocytes bearing the sex-chromatin marker of the female donor; prolonged survival, as compared to six irradiated control animals that were not given marrow; and cellularity of marrow spaces and histologic evidence of marrow function at autopsy. It was found that marrow transplants usually succeeded after 800 to 1200 r of total-body irradiation when the infused marrow was taken from litter-mate sisters or from mothers (15 successes in 17 attempts). Marrow transplants between unrelated animals appeared more difficult but were not impossible. One success was obtained in five attempts, and this success was achieved with the coincidental use of splenectomy, ACTH, and a large dose of marrow. Dogs with successful transplants lived longer than did control animals; in this series two to 10 times as long. When they died, they died of common canine infectious diseases and not of marrow failure. Distemper, hepatitis, and leptospirosis, with or without superimposed bacterial respiratory disease, were the common causes of death. The lymph nodes and the splenic follicles of irradiated animals had, in most instances, not regained normal histologic appearance at the time of death from these infectious diseases. The working hypothesis is advanced that infusions of marrow repopulate marrow spaces in the canine after irradiation but are poor sources of the type of cell needed to restore lymphoid function and immunologic effectiveness in lymph nodes and spleen. (auth)

5907 A STUDY OF MOUSE OVARIAN FUNCTION AFTER IRRADIATION. Charles A. Ely (Columbia Univ., New York). Cancer Research 20, 1625-30(1960) Dec.

Intermittent injection of antigonadotropic sera into irradiated mice resulted in regularly renewed vaginal cycles. The frequency of newly initiated cycles fell the third week after exposure but returned to previous levels within a few weeks. Antigonadotropic serum prevented this fluctuation. The mechanism of induction of ovarian tumors is discussed in the light of these findings. (auth)

5908 THE EFFECT PRODUCED BY IRRADIATION OF SPERMATOZOIDS WITH γ-RAYS ON FERTILIZATION AND EARLY DEVELOPMENT STAGES OF RABBITS. N. I. Nuzhdin and G. V. Nizhnik. Doklady Akad. Nauk S.S.S.R. 134, 1457-60(1960) Oct. 21. (In Russian)

The effects of radiation on rabbit spermatosoids (in vitro) were investigated in chinchilla-type rabbits. The results show strong radioresistance. Exposures of 100 to 15000 r do not prevent insemination. However, the radiation effects are later expressed in embryo development, the degree of disturbance depending on dosage. Sperm irradiation in vivo followed by impregnation induced identical disturbances in early embryo development. However, no progenies were born to female rabbits impregnated by sperm irradiated in vivo. (R.V.J.)

5909 COMBINED ACTION OF MYLERAN AND X-RAYS AND ITS GENETIC IMPORTANCE. Jean Moutschen (Inst. of Forestry Research, Stockholm and Universitè, Liège). Hereditas 46, 471-80(1960). (In French)

Seeds treated with Myleran (1:4-dimethanesulfonyloxybutane) before and after irradiation with x rays show a considerably modified effect on chromosome breakage. Twenty minutes of immersion in a solution containing 20 mgr per 100 cc of Myleran inhibit the majority of chromosome bridges observed after x raying. Treatment of seeds after irradiation modifies the effect of x rays on chromosomes according to the time when the compound was given. If seeds are treated 16 hours following irradiation, the average number of chromosome bridges is considerably increased but never reaches the level obtained with x rays alone at the same dosage. Modifications of chromosome break distribution have been observed and some applications of this combined action of mutagenic agents in the field of cytogenetics have been stressed. (auth)

5910 SOMATIC MUTATIONS OF FOUR GENES FOR ALBINISM IN BARLEY INDUCED BY X-RAYS AND ETHYL METHANESULPHONATE. Ewald A. Favret (Instituto de Fitotecnia, Castelar, Argentina). Hereditas 46, 622-34 (1960). (In English)

The forward mutation frequencies of four genes for albinism in barley were studied by means of treatments with x rays and ethyl methanesulfonate. The method consisted in scoring the number of chlorophyll deficient streaks on leaves of the M_1 plants, comparing heterozygous and homozygous strains. The genes analyzed were alb_1, alb_{20}, alb_{14}, and alb_{15}. All of them mutated in x rays. (auth) ments with similar frequency. The ethyl methanesulfonate, on the other hand, gave mutations in alb_1 and none in the other three genes. It is concluded that ethyl methanesulfonate has a selective mutagenic effect. This chemical is a more efficient as well as a more effective mutagen than x rays. (auth)

5911 STUDIES OF IRRADIATED MOUSE POPULATIONS. I. PLANS AND REPORT OF THE 1st GENERATION. K. G. Lüning (Lab. of Radiation Genetics, Stockholm). Hereditas 46, 668-74(1960). (In English)

The plan of a study concerning the effect of irradiation of spermatogonia during successive generations in a mouse population is presented. The results from the first generation have failed to show any deterioration in the irradiation series when compared with simultaneous controls. There was a lower rate of death before weaning in the irradiation series compared to the controls. This might be spurious and will be further studied in succeeding generations. (auth)

5912 THE CHANGE OF RADIOSENSIBILITY OF ANIMALS AS A RESULT OF PRELIMINARY X-IRRADIATION. N. I. Nuzhdin, M. D. Pomerantseva, and N. N. Kuznetsova (Inst. of Genetics, Academy of Sciences, Moscow). Izvest. Akad. Nauk S.S.S.R., Ser. Biol. No. 6, 851-64(1960) Nov.-Dec. (In Russian)

It was shown that a single-stage preliminary x-irradiation in sublethal doses may increase the survival of mice after their repeated irradiation with a heavy dose. The protective effect was observed when the preliminary doses of some 50 to 250 r for 14 days were utilized before repeated irradiation with 600 r. The protective effect was observed only with respect to survival and was not found while studying the body weight, the testicle weight, and picture of peripheral blood. (auth)

5913 IRRADIATION AND MARROW TRANSPLANTATION. STUDIES IN COOPERSTOWN. E. Donnall Thomas and Joseph W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Lancet 1289-90(1960) June 11.

Results are reported on 20 patients with leukemia treated with intravenous infusion of fresh or glycerol-frozen bone marrow preceded by whole-body doses of 100 to 600 r x radiation. Results are also reported on four patients with normal identical twins given infusions of fresh marrow from the normal twin after irradiation with 850, 1140, 1600, or 2000 r. It is concluded that the treatment was helpful in

some patients with leukemia. Results are reported from studies in dogs which support the conclusions. (C.H.)

5914 CHANGES IN THE FUNCTIONAL CONDITION OF THE HYPOPHYSIS CEREBRI UNDER THE EFFECT OF IONIZING RADIATION. A. V. Lebedinskii and V. V. Yakovlev. Med. Radiol. 5, No. 10, 21-5(1960) Oct. (In Russian)

A study was made of the reaction of pigment cells in a frog to light stimuli before and after exposition of the animal to different doses of ionizing radiation. Evidence was brought that under the effect of irradiation, the melanophores assume an increasingly dispersed shape. The period during which the darkening of the frog's integuments was noted varied in different series of experiments: it was maximal in individual species irradiated with a lower dose and minimal in those exposed to radiation in high dose. The failure of the melanophores could be seen to respond to the light stimuli occurring more frequently as larger doses were applied to the animal. (auth)

5915 THE INFLUENCE OF IRRADIATION ON THE MYELOID CELLS LYSIS OF THE AQUEOUS HUMOR. Yu. M. Zaretskaya. Med. Radiol. 5, No. 10, 25-8(1960) Oct. (In Russian)

For the purpose of determining optimal terms of myeloid elements transfusion in radiation injuries, a study was made of the lysis of myeloid cells of the aqueous humor, which by their chemical composition are analogues of tissue fluid. Heterologic myeloid cell (rat) lysis by rabbit's aqueous humor was used. Twenty four hours after total irradiation of rabbits in a dose of 1000 r, the lytic activity of the aqueous humor decreased. A noticeable drop of the lytic activity of the aqueous humor 5 to 7 days following irradiation is observed. (auth)

5916 THE PROTECTIVE EFFECT OF LOCAL BONE MARROW ASPHYXIA IN ACUTE RADIATION SICKNESS IN ANIMALS. P. G. Zherebchenko, I. G. Krasnykh, N. P. Lebkova, and S. P. Yarmonenko. Med. Radiol. 5, No. 10, 28-35(1960) Oct. (In Russian)

In experiments on mice, rats, and dogs, a study was made of the effect of local bone marrow asphyxia on the course and outcome of radiation sickness. Asphyxia was induced by applying a hemostatic tourniquet on the extremity of animals during irradiation. It was established that local asphyxia of the bone marrow alleviates the severity of acute radiation sickness and increases the survival of animals. It is shown that at the basis of the radioprotective action lies the reduced degeneration of the bone marrow, subsequently facilitating the regeneration of hematopoiesis. Data are obtained relative to the intensification of the effect of local asphyxia with the aid of prophylactic (mercamine) and curative (streptomycin) agents. (auth)

5917 EXCRETION OF DICHET-POSITIVE SUBSTANCES WITH THE URINE IN ANIMALS OF VARIOUS SPECIES FOLLOWING INJURY CAUSED BY IONIZING RADIATION. T. A. Fedorova, M. S. Uspenskaya, S. S. Vasileiskii, and E. M. Belyaeva. Med. Radiol. 5, No. 10, 42-7(1960) Oct. (In Russian)

Following exposure to lethal doses of ionizing radiation, mice, rabbits, and dogs were noted to excrete with the urine dichet-positive substances. The amounts and dates of their discharge differed according to individual species. In mice and dogs, it took place during the first 24 hr and comprised on the average 100 and 40%, respectively. In rabbits, during the first 2 hr there was a reduction in the level of these substances in the urine, amounting to 48% and its rise became evident only at later dates following irradiation, being equal to 80% by the 3rd day and 51% by the 5th day. All the animal species under observation showed a certain parallelism in the dynamics of the dichet-positive substances excretion together with the diurnal urinary out—out and of the changes in the diuresis following their irradiation. The results of the experiments make it possible to consider the estimation of dichet-positive substances in the diurnal urinary output of the animal species examined as a convenient test for a radiation injury. (auth)

5918 CERTAIN TRENDS IN THE SEARCH FOR PROTECTIVE COMPOUNDS WITH THE AID OF MODEL EXPERIMENTS. G. E. Fradkin. Med. Radiol. 5, No. 10, 47-51(1960) Oct. (In Russian)

The results are given of experiments on the protection of B. coli phage Ph-1 from γ-ray inactivation with the aid of derivatives of uracil and barbituric acid. An opinion is set forth on the mechanism of the protective effect of chemical compounds and inferences are given on the protective action being dependent upon the nature of substitutes in the side chain and on the character of position of substituting groups in the pyrimidine ring. (auth)

5919 ON THE MECHANISM OF INJURY OF FETUSES IN GRAVID ANIMALS WITH RADIATION SICKNESS. N. A. Kalinina (Inst. of Obstetrics and Gynecology, Academy of Medical Sciences, USSR). Med. Radiol. 5, No. 10, 52-6 (1960) Oct. (In Russian)

An assessment is made of the importance of the maternal organism in the mechanism of injury of the fetus during x-ray irradiation of gravid animals. A confrontation of the severity of radiation sickness in pregnant rats with the severity of injury of the fetuses divulged that in irradiation during the period before implantation in the mechanism of fetus injury of great importance are changes occurring in the irradiated organism of the mother; irradiation at the time of completed placentation produces a lesser deleterious effect on the state of the fetus than in earlier periods of gestation. Disturbance of lactation and of the maternal instinct in the animals subjected to the action of ionizing radiation is one of the causes of postnatal death of the progeny of the irradiated rats. (auth)

5920 SOME DATA ON HIGH DOSE RADIATION EFFECTS. L. B. Koznova and V. G. Kruschev. Med. Radiol. 5, 61-7(1960) Oct. (In Russian)

Data are given on roentgen apparatus specially created for studying the influence of the power value of the dose on the effect of radiation action. A comparison was made of the biological effect of roentgen rays with dose values of 130 and 1.3 r/sec during whole-body irradiation of mice. Doses from 390 to 1300 r were used. At a dose level of 390 and 520 r there was seen an inconsiderable decrease of the biological effect of powerful radiation as compared with the effect of x rays in a dose value of 1.3 r/sec (the mortality of the animals diminished by 15%). With increase of the radiation dose, the differences of the effect become insignificant, whereas in absolute lethal dose they disappear altogether. (auth)

5921 TUMOURS OF THE SMALL INTESTINE IN RATS AFTER INTESTINAL X-IRRADIATION. S. Marks and M. F. Sullivan (General Electric Co., Richland, Wash.). Nature 188, 953(1960) Dec. 10. (HW-SA-1996)

The incidence of intestinal tumors in irradiated rats is

reported for 51 rats irradiated at an age of 5 months and killed between 9 and 30 months later. The irradiation was performed either on the exteriorized intestine (delivered through an incision) while the rest of the body was shielded, or on the abdominal region, and the doses were varied from 700 to 1900 r (mid-lethal range). The tumors appeared in the small intestine and were observed predominantly in the upper part of the dose range. (D.L.C.)

5922 INFLUENCE OF DEEP HYPOTHERMIA UPON SENSITIVITY OF RATS TO X-RADIATION. Riccardo Benvenuto and F. John Lewis (Northwestern Univ., Chicago). Surg. Forum 10, 558-60(1960).

The protective effect of deep hypothermia has been studied in rats. A single x-ray dose of 800 and 1500 r, respectively, has been administered to rats while in deep hypothermia. Each group had a control series of animals exposed to the same amount of radiation at normal temperature. A mortality rate of 100% in 4 weeks has been observed in the controls. Among the rats irradiated in hypothermia a survival rate of 83.3% in 4 weeks for the rats receiving 800 r and a survival rate of 60% in 4 weeks for those receiving 1500 r has been obtained. (auth)

5923 EOSINOPHILIA DEVELOPED DURING X-RAY THERAPY. Iori Ueno, Takao, Sugikhara and Khisao Nishida (Kyoto Univ.). Vestnik Rentgenol. i Radiol. 35, No. 5, 55-8(1960) Sept.-Oct. (In Russian)

Seven cancer patients were given a daily x-ray dose of 250 to 415 r. The eosinophil count increased from a low of 2 to 5% to a high of 10 to 30% during the course of the treatment. At a total dose of 6000 to 9000 r, two of the patients clearly had eosinophilia; and the others showed a tendency to either an absolute or a relative increase in eosinophil count. Previously reported cases of eosinophilia were observed directly after irradiation or during the recovery state, but not during the process of irradiation, as the present seven cases were. The reasons for the development of eosinophilia caused by radiation are not clear. (TTT)

5924 TREATMENT OF ZIRCON. Alfred Richard Burkin and Beresford Thomas Kingcome Barry (to National Research Development Corp.). British Patent 853,301. Nov. 2, 1960.

The silica content of zircon can be reduced by leaching with an aqueous caustic alkali solution at temperatures above 270°C to dissolve the silica, and a method is outlined for carrying this out. The leaching solution preferably is 15 to 28 wt. % caustic alkali and 6 to 12 wt. % alkali metal carbonate, the leaching temperature is 270 to 320°C, and the zircon particles are less than 74 μ in size, preferably 1 to 5 μ. The effects of the variables, e.g., leaching solution concentration and particle size, on the method are discussed, and the method is illustrated with ten examples. (D.L.C.)

Radiation Sickness

5925 (JPRS-7270) ELECTROPHORETIC STUDY OF SOLUBLE LIVER PROTEINS IN RADIATION SICKNESS. (Elektroforeticheskoye Izucheniye Rastvorimykh Belkov Pecheni pri Luchevoy Bolezni). E. (Ye.) M. Belyaeva (Belyayeva), T. A. Fedorova, and S. S. Vasileskii (Vasileyskiy). Translated from Voprosy Med. Khim. 6, 377-81(1960). 10p. OTS.

In separating, by means of paper electrophoresis, soluble proteins of the liver of rats, it has been found that in normal liver the quantity of proteins corresponding in mobility to the albumins of the blood serum equals 9.6%; α-globulins, 21.8%; β-globulins, 38.8%; and γ-globulins, 23.6%. The slow-moving fraction of liver proteins was 6.2%. A study was made of the changes in soluble liver proteins contents at various periods following x-ray irradiation with a 650 r dose. The following was ascertained: there was a 21.3% decrease in the content of proteins that correspond in their mobility to β-globulins of the serum; a 51.2% increase of the content of fractions corresponding in mobility to serum α-globulin during the first 24 hr; and an increase in serum γ-globulins starting within three days after irradiation. From the 3rd to 7th day, all the above-mentioned changes showed progressive tendencies. As compared to normal liver, the content of proteins corresponding to serum β-globulins had decreased on the 7th day after irradiation by 46.2% and those corresponding to α- and γ-globulins had increased by 64.4 and 21.6%, respectively. Changes were observed in the ratio of protein fractions of the blood serum that are typical for radiation sickness. These changes were reduction of the albumin content and an increase in globulin fractions. (auth)

5926 RADIOLOGICAL WARFARE. Carl L. Hansen, Jr. (Univ. of Rochester School of Medicine and Dentistry, N. Y.). J. Am. Med. Assoc. 175, 9-11(1961) Jan. 7.

The acute radiation syndrome following whole-body exposure to external sources of ionizing radiation may be diagnosed with a fair degree of accuracy from the postirradiation clinical and physiological sequence of events. Patients exposed to doses in the range from 200 to 700 r will benefit the most from good medical management. Personnel exposed to less than this will need little or no care, and those exposed to much more than this will probably be in the lethal range, regardless of therapy. The single most valuable tool available to the average physician is the complete blood count with a differential count of the leukocytes. If detailed hematological studies are not available, the white-blood-cell count is probably the most useful. Since there is no specific pathology, treatment is symptomatic. Careful observation coupled with restraint in overloading the patient with medication is the best treatment. Bone-marrow transplantation may be indicated if the dose is more than 600 r of whole-body irradiation. The shielding of any part of the body may significantly modify the response to exposure of ionizing radiation and change the clinical course, prognosis, and therapy. (auth)

CHEMISTRY

General and Miscellaneous

5927 (AERE-R-3491) A POLAROGRAPHIC STUDY OF THE REACTION BETWEEN NITROSYLRUTHENIUM COMPLEXES AND HYDRAZINE. E. N. Jenkins (United Kingdom Atomic Energy Authority, Research Group, Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 25p. BIS.

Polarographic measurements on 7 x 10^{-4}M chloro complexes of ruthenium nitrosyls in 0.1M KCl and 0.1M HCl showed an electro-reduction to ruthenium (III), involving the consumption of five electrons and six hydrogen ions, with a half-wave potential of -0.27 volt (saturated calomel electrode). Nitrato complexes, $[RuNO(NO_3)_x]^{3-x}$, in 0.1 to 2.4M HNO_3 gave reduction currents which are considered due to a similar process. The higher nitrato complexes

were reduced at slightly lower potentials than the chloro complexes. The kinetics of the reduction of the ruthenium nitrosyls in group from the chloro complex (0.1M HCl) was followed by polarographic analyses and found to be 40% complete after 3 hr heating (95°) with 0.1M hydrazine sulfate; the corresponding reaction of the nitrato complex (0.1M HNO_3) was over 80% complete after 1 hr (70°) with 0.1M hydrazine nitrate. The elimination of nitrosyl from the nitrato complex required as little as 0.016M hydrazine nitrate in 0.03M HNO_3, and is not reversed upon subsequent aging in 2M HNO_3. The study is related to the use of hydrazine to convert nitrato complexes of ruthenium nitrosyls into less extractable forms during the processing of irradiated fuels. (auth)

5928 (GAT-T-799) COMMENTS ON REPORTS KL-670 AND GAT-T-700 CONCERNING TWO INFRARED METHODS FOR CALCULATING ISOMER PERCENTAGES IN DICHLOROTETRAFLUOROETHANE ($C_2F_4Cl_2$). F. C. Steinbach, E. A. Smith, and K. E. Beu (Goodyear Atomic Corp., Portsmouth, Ohio). Dec. 30, 1960. 45p. Contract AT(33-2)-1. OTS.

A comparison is made of the methods used by Goodyear Atomic Corporation and Oak Ridge Gaseous Diffusion Plant for calculating isomer percentages in dichlorotetrafluoroethane. (W.L.H.)

5929 (NYO-9561) MAGNETIC INVESTIGATIONS OF SPIN-FREE COBALTOUS COMPLEXES. VI: COMPLEXES CONTAINING PHOSPHINES AND THE POSITION OF PHOSPHINES IN THE SPECTROCHEMICAL SERIES. F. A. Cotton, O. D. Faut, and D. M. L. Goodgame (Massachusetts Inst. of Tech., Cambridge) and R. H. Holm (Harvard Univ., Cambridge, Mass.). [1960]. 22p. Contract AT(30-1)-1965. OTS.

Thorough study of the magnetic moments and the visible spectra of the complexes $[Co(R_3P)_2X_2]$ (R = ϕ, X = Cl, Br, I and R = C_6H_{11}, X = Br, I) and of salts of two representatives of an anionic complex, $[Co(\phi_3P)Br_3]^-$ and $[Co(\phi_3P)I_3]^-$, are reported. The effect of low-symmetry components in the ligand fields upon the magnetic and spectral properties is reported and discussed. By comparison of the data with previously reported data on other tetrahedral Co(II) complexes, it is shown that the two phosphines occupy a position in the spectrochemical series adjacent to toluidine and NH_3. (auth)

5930 (TID-11016) TECHNICAL PROGRESS REPORT [ON CHEMISTRY]. Stanley Windwer and Benson Ross Sundheim (New York Univ., New York). Nov. 1, 1960. 85p. Contract AT-30-1-1837. OTS.

Determination of the electron paramagnetic resonance spectra of sodium, potassium, and rubidium solutions in ethylenediamine is reported. The determination of the absorption spectra of sodium, sodium plus sodium iodide, potassium, and rubidium solutions in ethylenediamine is presented. A determination was made of the electrical conductivity of potassium solutions in ethylenediamine as a function of absorptivity. Preliminary observations were made of the kinetics and the products of the decomposition reaction. (W.L.H.)

5931 (TID-11093) THE PREPARATION OF A SOLUTION OF HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID FROM A SOLUTION OF TRISODIUM HYDROXYETHYLETHYLENEDIAMINETRIACETATE AND THE SEPARATION OF OXALIC ACID-HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID SOLUTIONS BY MEANS OF ION EXCHANGE. Report No. 237. Period [covered]: December 27, 1957–August 8, 1958. J. R. Morton (Michigan Chemical Corp., St. Louis, Mich.). 19p. Project No. 942. OTS.

A method for the semicontinuous preparation of hydroxyethylethylenediaminetriacetic acid (HEDTA) by means of ion exchange from a 41% solution of trisodium hydroxyethylethylenediaminetriacetate is presented. The yield of hydroxyethylethylenediaminetriacetic acid from the 41% trisodium hydroxyethylethylenediaminetriacetate solution was 82% of the theoretical yield. Separation of an yttrium concentrate produced in the liquid-liquid contactor with the hydroxyethylethylenediaminetriacetic acid prepared in the pilot plant gave a yield of 73.4% of the yttrium oxide recovered from the columns as high purity yttrium oxide. An hydroxyethylethylenediaminetriacetic acid solution free of oxalic acid was recovered in 95% yield from a solution of oxalic acid and hydroxyethylethylenediaminetriacetic acid. A method for the analysis of solutions containing hydroxyethylethylenediaminetriacetic acid and oxalic acid was developed. (auth)

5932 (UCRL-9208) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT FOR MARCH, APRIL, MAY 1960. (California. Univ., Berkeley. Lawrence Radiation Lab.). June 29, 1960. 135p. Contract W-7405-eng-48. OTS.

Separate abstracts have been prepared on 16 sections of this report. (C.H.)

5933 (UCRL-9208(p.4-11)) THE ENERGY BARRIER BETWEEN THE ENANTIOMERS OF 1,2-DITHIANE. Goran Claeson and Gaylord Androes (California. Univ., Berkeley. Lawrence Radiation Lab.).

The dihedral angle in an organic disulfide can produce two different molecular conformations. These conformations are optical antipodes, and their stability depends on the height of the rotational barrier hindering free rotation about the disulfide bond. Results are reported from a nuclear magnetic resonance study of the interconversion between the enantiomers of the cyclic disulfide 1,2-dithiane. (C.H.)

5934 (UCRL-9208(p.34-9)) PHOTOINDUCED ESR SIGNALS IN A CAROTENOIDLESS MUTANT OF RHODOPSEUDOMONAS SPHEROIDES. Gaylord Androes and Mary Singleton (California. Univ., Berkeley. Lawrence Radiation Lab.).

Progress is reported on an investigation of the photoinduced electron spin resonance (ESR) signals from biological materials. It has not yet been shown that the photoinduced signal is intimately connected with the process of photosynthesis. One way of showing such a correlation might be to remove various substances known to be involved in photosynthesis from the plants to see what effect this has on the observed ESR signal. Advantage was taken of the fact that some suitable photosynthetic materials can be made to exist in a mutant as well as a wild form. In Rhodopseudomonas spheroides, the wild type (R.S.w) has a full complement of pigment molecules, whereas the blue-green mutant (R.S.m) lacks the carotenoids. Since these pigments have been shown to be related to the photosynthetic process, their absence could have an effect on the photoinduced signal. The photoinduced ESR signals arising in R.S.w and R.S.m were compared as a function of various parameters. Data are reported and results are discussed. (C.H.)

5935 (UCRL-9208(p.40-52)) STUDIES ON THE OCCURRENCE OF MANGANESE PHAEOPHYTIN IN PLANTS.

Edward Markham (California. Univ., Berkeley. Lawrence Radiation Lab.).

The initial stage of the photosynthetic cycles requires the capturing and conversion of electromagnetic energy to electronic potential energy. This occurs through the agency of the chlorophyll pigment system. A conceivable mechanism for such a process may be envisaged as follows: the chlorophyll molecule, through the absorption of light energy, is raised to an excited state and then returns to the ground state by passing on its light energy to a receptor molecule. The actual energy conversion would then be carried out by the receptor molecule. Results are reported from an investigation of the role of manganese phaeophytin as a receptor molecule. (C.H.)

5936 (UCRL-9208(p.53-61)) ELECTRICAL PROPERTIES OF ORGANIC SOLIDS. PART III. EFFECTS OF ADDED ELECTRON ACCEPTORS ON THE ELECTRICAL AND MAGNETIC PROPERTIES OF METAL-FREE PHTHALOCYANINE, VIOLANTHRENE, TETRACENE, AND PERYLENE. David R. Kearns (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a study of the effects of added electron acceptors on the electrical and magnetic properties of metal-free phthalocyanine, violanthrene, tetracene, and perylene. Iodine and tetracyano ethylene were the electron acceptors investigated. The apparatus used for the conductivity samples is illustrated. The results of conductivity and electron spin resonance measurements and determinations of solid-state ionization potentials of the pure dyes are tabulated. If the effect of orthochloranil on the dark conductivity of the various dyes is considered, there appears to be an inverse relation between the increase in conductivity and the solid-state ionization potential. (C.H.)

5937 (UCRL-9208(p.62-4)) ELECTRICAL PROPERTIES OF ORGANIC SOLIDS. PART IV. THERMOELECTRIC POWER. David R. Kearns (California. Univ., Berkeley. Lawrence Radiation Lab.).

The thermoelectric power measurement is a method used to determine the sign of the majority charge carrier in a semiconductor. Applications in determinations of the sign of the charge carrier in organic substances were investigated. (C.H.)

5938 (UCRL-9208(p.65-8)) ELECTRICAL PROPERTIES OF ORGANIC SOLIDS. PART V. NON-OHMIC BEHAVIOR OF METAL-FREE PHTHALOCYANINE. David R. Kearns (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from an analysis of the phthalocyanine current-voltage characteristics in terms of a combination of carriers generated in the phthalocyanine layer and carriers forced into the phthalocyanine from the electrodes. If the experimental data are correct, it follows that graphite electrodes form ohmic contacts with phthalocyanine. (C.H.)

5939 (UCRL-9208(p.69-76)) SOLID-STATE IONIZATION POTENTIALS OF SOME AROMATIC ORGANIC COMPOUNDS. David R. Kearns (California. Univ., Berkeley. Lawrence Radiation Lab.).

Measurements were made of the gaseous and solid-state ionization potentials of some aromatic organic compounds. The compounds chosen for the initial experiments were metal-free phthalocyanine, violanthrene, decacyclene, tetracene, perylene, and phenothiazine. The experimental apparatus and sample cell are described. Data are tabulated. (C.H.)

5940 (UCRL-9208(p.78-83)) ROUTES TO THE CHEMICAL SYNTHESIS OF BRANCHED-CHAIN SIX-CARBON ACIDS. Emma J. McDonald (California. Univ., Berkeley. Lawrence Radiation Lab.).

A study was made of branch-chained acids related to ribulose. The structure of tannin isolated from Hamamelis virginiana (witch hazel) and epimeric forms of D-hamamelonic acid are presented. A gas chromatographic method is described for the separation of diisopropylidene arabinose, diisopropylidene ribulose, and 2,3-monoisopropylidene-1,5-anhydro-ribose. Routes to chemical synthesis were studied, and the similarity to photosynthetic products was discussed. (C.H.)

5941 (AWRE/TRANS/10) COMPLEX COMPOUNDS OF BERYLLIUM WITH β-DIKETONES. E. S. Przheval'skiĭ and L. M. Moiseeva. Translated by F. E. Wallwork from Vestnik Moskov. Univ., Ser. Mat., Mekhan., Astron., Fiz. i Khim. 14, No. 1, 203-10(1959). 10p. JCL.

A review of information on complex compounds of beryllium with β-diketones is presented. It was found that diketones are suitable reagents for analytical purposes. Under proper conditions these compounds deposit beryllium from aqueous solutions. Aluminum diketone compounds resemble the corresponding beryllium compound; however, considerable difference is noted in magnesium. (J.R.D.)

5942 (UCRL-Trans-484(L)) CALORIMETRIC METHOD FOR DETERMINING THE PRESENCE OF ION ASSOCIATION IN SOLUTIONS OF ELECTROLYTES. E. V. Kiseleva. Translated from Nauch. Doklady Vysshef Shkoly, Khim. i Khim. Tekhnol., 621-3(1958). 5p. JCL or LC.

A method is presented for quantitative evaluation of the number of ions in a mixture. It was found that ΔHc (difference in heat of mixture of completely dissociated electrolyte in a mixture of known electrolyte and water) is directly proportional to the number of ions in the mixture. A number of determinations made by the method agree with calculated values. (T.R.H.)

5943 NOTE ON EVAPORATION. S. A. Zwick (Univ. of California, Livermore). J. Appl. Phys. 31, 1735-41 (1960) Oct.

A simple kinetic model is employed to investigate nonequilibrium evaporation from a liquid. Molecules are assumed to evaporate into a (one-sided) Maxwellian velocity distribution at the liquid surface. Molecules reaching the surface from the vapor are assumed to form part of an ellipsoidal velocity distribution. Of the molecules approaching the liquid at the interface only the fraction α condenses there; the remainder presumably undergoes specular reflection back into the vapor. By equating physical conditions at the surface with conditions in the vapor, the vapor pressure can be related to that which would prevail at equilibrium, as a function of the surface accommodation coefficient α and the mean velocity u of the vapor relative to the interface. (auth)

5944 PREPARATION OF THE FORMATES OF RARE EARTH ELEMENTS. Balaram Sahoo, S. Panda, and D. Patnaik (Ravenshaw Coll., Cuttack, India). J. Indian Chem. Soc. 37, 594(1960) Sept. (In English)

A method for preparing the formates of lanthanum, cerium, and thorium is given in which nitrates are reacted with formic acid. Analysis shows the products are free from nitrogen and have 0.25 mole water associated with each mole. (D.L.C.)

5945 OBSERVATIONS ON THE RARE EARTHS. LXXII. THE PREPARATION AND CHARACTERIZATION

OF ANHYDROUS AND N,N-DIMETHYLFORMAMIDE-SOLVATED ACETATES. T. Moeller, V. Galasyn, and J. Xavier (Univ. of Illinois, Urbana). J. Inorg. & Nuclear Chem. 15, 259-64(1960) Oct. (In English)

Rare-earth metal and yttrium acetates were effectively dehydrated by treatment with N,N-dimethylformamide and benzene, followed by azeotropic distillation. Ansolvous acetates, $Ln(C_2H_3O_2)_3$ were obtained where Ln = Y, La, Dy, Ho, Er, and Yb; but where Ln = Ce(III), Pr, Nd, Sm, Eu, or Gd, monosolvated acetates, $Ln(C_2H_3O_2)_3 \cdot DMF$, have resulted. The latter compounds are readily converted to the ansolvous materials by heating in vacuo at 210°C. Ansolvous and dimethylformamide-solvated acetates were characterized by means of analysis, x-ray diffraction, and infrared measurements. (auth)

5946 STUDIES ON COÖRDINATION COMPOUNDS. XIX. FORMATION CONSTANTS OF SOME METAL DERIVATIVES OF β,δ-TRIKETONES. Hidehiko Kido and W. Conard Fernelius (Pennsylvania State Univ., University Park). J. Phys. Chem. 64, 1927(1960) Dec. (NYO-8774)

The dissociation constants of 1-phenyl-1,3,5-hexanetrione and 1,5-diphenyl-1,3,5-pentanetrione were measured in 75 volume % dioxane at 30° as well as the formation constants of complexes with uranyl, copper(II), nickel, cobalt, zinc, and cadmium ions. The triketones are monobasic and function as bidentate ligands. (auth)

5947 DATA SHEET NO. 39. SPECIFIC-ACTIVITY NOMOGRAM. T. Alex Eastwood (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucleonics 19, No. 1, 64(1961) Jan.

A nomogram is given from which values may be obtained for the specific activity (dps/g) of a pure radioisotope, total activity for a sample of given weight, or the weight required to give a particular total activity. The nomogram may be used to check for arithmetical errors in calculations. The values obtained are within ±20% of correct values. An example is given for determining the activity of 1 μg of Ru^{106}. (B.O.G.)

5948 APPLICATION TO ION EXCHANGE STUDY OF AN INTERFEROMETRY METHOD. S. Goldsztaub (Université, Strasbourg) and R. Platzer. Silicates inds. 24, 419-20(1959). (In French) (CEA-1383)

The numerous experiments carried out on ion exchange between clay suspensions and solutions have so far been done by studying the equilibrium between the two phases; by this method it is very difficult to obtain the kinetic properties of the exchange reactions. A method consisting of observation with an interferential microscope using polarized white light shows up the variations in concentration which take place during the ion exchange between an ionic solution and a montmorillonite slab as well as between an ionic solution and a grain of organic ion exchanger. By analyzing the results it will be possible to compare the exchange constants of organic ion exchangers with those of mineral ion exchangers. (auth)

5949 IMPROVEMENTS IN OR RELATING TO ION-EXCHANGE RESINS. John Kennedy (to United Kingdom Atomic Energy Authority). British Patent 855,009. Nov. 23, 1960.

Amphoteric ion-exchange resins containing monoallyl-substituted aminomethyl phosphonate groups can be prepared by reacting a polymer of diallyl hydrogen phosphonate with a mixture of an aliphatic aldehyde or ketone and a primary or secondary amine and then partially hydrolyzing the product. The resulting resins have a greater affinity for divalent transition metal ions than for uranyl ions and can be used for uranium separation. Details of the method of resin preparation are given in one example. (D.L.C.)

Analytical Procedures

5950 (AERE-C/R-2161) THE CHEMICAL ANALYSIS OF BINARY ALLOYS OF PLUTONIUM WITH ALUMINUM, IRON OR URANIUM. D. H. F. Atkins and E. N. Jenkins (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 23p. BIS.

Methods for the chemical analysis of binary alloys of plutonium with aluminum, iron, and uranium were developed. All of the methods rely on the retention of plutonium on columns of De-Acidite FF by anion exchange from solutions 7M in nitric acid. The alloying elements, which are not retained under these conditions, are determined by conventional methods after separation from plutonium. Plutonium is recovered from the anion exchange column under reducing conditions and determined by differential absorptiometry. Experimental details of the methods employed and results obtained in the analysis of a number of alloys are included. (auth)

5951 (AERE-I/R-2208(Suppl.1)) RADIOACTIVATION ANALYSIS—A BIBLIOGRAPHY, FIRST SUPPLEMENT. D. Gibbons, D. Mapper, R. J. Millett, and H. Simpson, comps. (United Kingdom Atomic Energy Authority. Research Group. Wantage Radiation Lab., Harwell, Berks, England). Oct. 1960. 36p. BIS.

This bibliography contains 263 references to literature on radioactivation analysis which appeared from June 1957 to July 1960. A subject index is included. (J.R.D.)

5952 (CF-59-7-127) DETERMINATION OF Li^6 IN AQUEOUS SOLUTION BY NEUTRON ACTIVATION ANALYSIS. J. W. Winchester, L. C. Bate, and G. W. Leddicotte (Oak Ridge National Lab., Tenn.). July 10, 1959. 6p. OTS.

A method for determining the concentration of Li^6 in aqueous solution was tested using the nuclear reactions $Li^6(n,\alpha)H^3$ and $O^{16}(H^3,n)F^{18}$. Annihilation γ radiation of induced 1.87-hr F^{18} radioactivity was counted with a well-type scintillation counter, and the radioactivity per millimole of lithium was found to be independent of lithium concentration below about 0.2 moles/liter. The sensitivity limit for detecting lithium is less than 0.1 micromole (0.0075 micromole Li^6). (auth)

5953 (CRRL-982) THE DETERMINATION OF DISSOLVED GASES IN HIGH-TEMPERATURE, HIGH-PRESSURE WATER SYSTEMS. G. M. Allison, I. H. Crocker, and J. F. Atherley (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oct. 1960. 28p. (AECL-1138). AECL.

Presented at the Fourth Conference on Analytical Chemistry in Nuclear Reactor Technology at Gatlinburg, Tennessee, October 12-14, 1960.

A method of determining H_2, O_2, CO_2, N_2, and He dissolved in water is presented. It has been used for several years in the analysis of samples from in-reactor loops. Sampling is usually done on a cooled by-pass of the pressurized-water system. The sample is taken into an evacuated flask fitted with a three-way stopcock, which enables the line between the sampling valve and stopcock to be flushed or evacuated. The gases are separated from the water sample in a vacuum system using a conventional Toepler pump. The volume of the gas obtained is meas-

ured in a gas burette and an aliquot is used for the determination of the individual components. Oxygen is removed by catalytic combination with hydrogen; excess hydrogen is removed by diffusion through a palladium thimble; CO_2 is frozen out in a liquid-nitrogen trap; and nitrogen is removed on activated charcoal at liquid-nitrogen temperature. The gas remaining is helium. The amounts present are calculated from the drop in pressure in the system as each component is removed. (auth)

5954 (MCW-1462) THE DETERMINATION OF HYDROGEN IN URANIUM BY MASS SPECTROMETRY. L. A. Fergason, D. E. Seizinger, and C. H. McBride (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Jan. 2, 1961. 15p. Contract W-14-108-eng-8. OTS.

Presented at the First Conference on Nuclear Reactor Chemistry, Gatlinburg, Tennessee, October 1960.

A method was developed for the determination of hydrogen in uranium metal by mass spectrometry. The samples are introduced into a tube containing helium at atmospheric pressure. Hydrogen gas evolved from the heated sample is mixed with a helium gas stream flowing through the tube and over the sample at a constant rate. The effluent gas mixture is monitored at m/e2. The resulting rate-of-evolution curve is integrated with respect to time with an electronic integrator. The empirical number so obtained is directly proportional to the hydrogen content of the metal. The method was adapted to time-of-flight and magnetic mass spectrometers. The determination requires from 3 to 10 min on the mass spectrometer, depending on size of the sample and hydrogen content of the metal. Precision comparable to that of the classical vacuum technique is obtained. The technique described is also adaptable to the study of diffusion of hydrogen in uranium metal. (auth)

5955 (TID-7591(p.81-5)) AN EVALUATION OF THE ELECTRODEPOSITION METHOD FOR THE DETERMINATION OF ENRICHED URANIUM IN URINE. Robert L. Hancock and Gerald S. Golden (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.).

An evaluation was made of the electrodeposition technique for the determination of enriched uranium in urine. The effect of storage in polyethylene bottles on the uranium content of urine was also investigated. Data are tabulated. (C.H.)

5956 (TID-7591(p.86-91)) A STATISTICAL APPROACH TO URINALYSIS. Randi Lie (Rochester, N. Y. Univ. Atomic Energy Project).

In distribution-excretion studies animals are injected with a known quantity of the isotope in question, and urine and feces are collected daily from several of the experimental animals. Urinalysis consists of counting the activity of the total daily urine output from each of these metabolism animals. The data may be expressed in terms of the administered dose, recovered dose, or body burden, with the use of average excretion values from the animals studied. Confidence intervals are useful as a means of data analysis. Tolerance factors are presented for use in studies of normal distribution in animals. Applications of the calculations in the statistical analysis of human data, based on fewer samples, are discussed. (C.H.)

5957 (TID-7591(p.92-8)) OPERATION OF A LABORATORY INTERCOMPARISON PROGRAM. John H. Harley (New York Operations Office. Health and Safety Lab., AEC).

A program is discussed for the comparison of results in the trace analysis of biological materials. Procedures are included for the preparation of samples for analysis of Sr^{90} content. Results are reported from the comparison of data on Sr^{90} content of samples. (C.H.)

5958 (AEC-tr-4208(p.124-45)) TOWARD A METHOD OF QUANTITATIVE SEPARATION OF HELIUM–NEON MIXTURES. G. M. Ermolin. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 109-38(1957).

A method was developed for the quantitative separation of the light inert gases which is based upon the differing adsorbability of activated charcoal for helium and neon at a temperature close to the critical point of neon. The method allows a direct quantitative determination of the helium and a quantitative determination of the neon by difference with a maximum mean error of ±2%. (W.L.H.)

5959 (UCRL-Trans-615(L)) FOCUSING ION EXCHANGE. II. RAPID QUALITATIVE ANALYSIS OF CATIONS. Preliminary Report. (Über Fokussierenden Ionenaustausch. II. Qualitative Schnellanalyse von Kationen. Vorläufige Mitteilung). Ernst Schumacher and Hans Jakob Streiff. Translated from Helv. Chim. Acta 40, 228-33(1957), 19p. (includes original, 9p.). JCL.

Focusing ion exchange is used to separate and identify cations. Groups II, III, and IV are separated in 5 minutes and in quantities of 10 μg per ion by using a pH gradient and ethylenediaminetetraacetate, nitrilotriacetate, chloride, and tartrate as complexing agents parallel with an electric field. Other means of producing a gradient in complex formation are mentioned. (W.L.H.)

5960 A RAPID METHOD FOR THE DETECTION OF ^{90}Sr CONTAMINATION IN ^{90}Y. R. F. Doering, W. D. Tucker, and L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.). J. Inorg. & Nuclear Chem. 15, 215-21(1960) Oct. (In English) (BNL-4440)

Yttrium-90, milked from its parent Sr^{90}, may be tested rapidly and simply for the presence of Sr^{90} contamination. After adding Y and Sr carriers, an aliquot is passed through a column of Dowex 1 × 10 in the hydroxyl form, and a portion of the effluent is evaporated to dryness and counted with and without absorber. Requiring less than 1 hr to perform, the method detects as little as 0.02 μc Sr^{90} in 100 mc Y^{90}. Larger aliquots can be used for even greater sensitivity. The mechanism of bonding the Y to the resin is shown to be via a yttrium-citrate complex. The performance of resins of other cross-linkages and in forms other than hydroxyl is discussed. (auth)

5961 ESTIMATION OF ALUMINIUM IN HIGH PURITY THORIUM COMPOUNDS. AN ION-EXCHANGE SEPARATION METHOD. V. T. Athavale and A. R. Subramanian (Atomic Energy Establishment, Trombay, India). J. Sci. Ind. Research (India) B 19, 431-2(1960) Nov. (In English)

A method for the separation of micro amounts of aluminum from thorium by absorbing the latter on an anion exchanger as negatively charged sulfate complex and subsequent spectrophotometric estimation of aluminum present in the effluent is described. By adjusting the pH of the test solution and that of the wash solution (distilled water acidified with sulfuric acid) to 2.1 ± 0.1, it has been possible to elute 30 μg of aluminum completely in 130 ml of effluent. (auth)

5962 CHROMATOGRAPHIC SEPARATION AND ESTIMATION OF TRACES OF URANIUM IN SOILS AND PLANT ASH. D. Purushottam (Andhra Univ., Waltair, Vizagapatam, India). J. Sci. Ind. Research (India) B 19, 449(1960) Nov. (In English)

Uranium present in traces (2.0 ppm) in soils and plant ash has been satisfactorily estimated by paper strip chromatography using a new solvent mixture, containing citric acid (0.2 g), acetone (18.0 ml), acetic acid (1.0 ml), and nitric acid (1 ml; 1 : 3). (auth)

5963 GRAVIMETRIC DETERMINATION OF CERIUM (III AND IV), LANTHANUM, YTTRIUM, URANIUM AND TITANIUM. B. D. Jain and S. P. Singhal (Univ. of Delhi). J. Sci. Ind. Research (India) 19B, 494-5(1960) Dec.

2,5-Dihydroxy-p-benzoquinone completely precipitates cerium, lanthanum, and yttrium at pH 2.5 to 3.0; uranium in the presence of ammonium chloride at pH 2.8 to 7.0; and titanium at pH 1.0. The precipitate in each case is ignited to oxide and weighed. (auth)

5964 DETECTION OF URANIUM, THORIUM AND IRON, AND DETERMINATION OF URANIUM BY MEANS OF RHAMNETIN. Zoltán Sámsoni. Magyar Tudományos Akad. Atommag Kutató Intézete (Debrecen), Közlemények 2, 185-91(1960). (In Hungarian)

For analytic purposes, several flavone derivatives and other organic preparations were studied regarding their behavior with uranyl ions. Mild color reactions were obtained in alkaline medium by robinin and resacetophenone. Rhamnetin proved to be best since it has at pH 12 to 13 a vivid reddish-brown color reaction with uranyl ions. The stability of the arising colored complex was investigated, and the permanence of color intensity was found to be favorably influenced by a mixture of $Na_2SO_3 + N_2H_4 \cdot HCl$ previously added to the sample. The arising color complex was stable for about half an hour, and afterwards the optic density increased in parallel with a slow, probably reducing, process of transformation. Within 1 to $1\frac{1}{2}$ hours it assumed a higher and final stable value. The absorption maximum of the rhamnetin-uranyl complex was found at 505 nm and 11,800 ± 120 was obtained for the final stable molar extinction-coefficient. Alkaline medium rhamnetin had an orange-yellow color reaction with thorium ions, an intensive greenish-brown color reaction with iron ions, and a less intensive greenish-yellow color reaction with cobalt ions. (auth)

5965 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM AND THORIUM WITH ARSENAZO. H. Perry Holcomb and John H. Yoe (Univ. of Virginia, Charlottesville, Va.). Microchem. J. 4, 463-80(1960) Dec.

A critical examination of the thorium-arsenazo complex is presented. Procedures are given for the spectrophotometric determination of thorium and for the determination of both thorium and uranium in the same solution. A method for the simultaneous separation of uranium and thorium by means of a mesityl oxide extraction is included. Application of the procedure is made in the analysis of three uranium- and thorium-bearing mineral samples and of 20 salt solutions. The precision and accuracy of the method are good. (auth)

5966 SIMULTANEOUS DETERMINATION OF SCANDIUM AND DYSPROSIUM BY NEUTRON ACTIVATION FOLLOWED BY γ-RAY SPECTROMETRY. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Nature 188, 575-6(1960) Nov. 12.

A neutron activation analysis method was devised for the nondestructive, simultaneous determination of dysprosium and scandium. The sample was irradiated with neutrons at a flux of 4×10^{10} nvt. The irradiated sample was alternately cooled and counted with a 256-channel pulse height analyzer. In the resultant γ spectrum the height of the photopeaks from the 0.142-Mev γ ray of Sc^{46m} and from the 0.108-Mev γ ray of Dy^{165m} are measured. (B.O.G.)

5967 A RAPID VOLUMETRIC METHOD FOR Si IN Al ALLOY. Masami Hasegawa. Nippon Kinzoku Gakkaishi 24, 493-6(1960). (In Japanese)

A method for the determination of silicon in aluminum alloys was developed which consists of the formation of K_2SiF_6 and its titration with NaOH. About 0.2 to 0.5 g of sample were placed in a 300 ml polyethylene conical beaker; 60 ml of hot (1 : 1) HNO_3 and 5 ml of HF were added. The sample was dissolved without heating, diluted with water to 100 ml, cooled rapidly to 20°C, and KNO_3 was added until the solution was saturated. The solution was filtered through No. 5A filter paper and the precipitate washed with cold washing solution (150 g KNO_3 in 850 ml distilled water and 150 ml alcohol) until the washings were acid-free. The paper and precipitate were transferred to a 500-ml beaker and 200 ml of carbon dioxide-free boiling water was added. The solution was titrated, while still hot, with NaOH solution, using 5 drops of phenolphthalein indicator. One ml of 0.5 N NaOH = 0.3508% Si. With aluminum alloys, this method is only interfered with by titanium, tantalum, and zirconium. The entire procedure can be carried out within 50 min. (auth)

5968 RAPID DETERMINATION OF Zn IN Al ALLOYS BY EDTA TITRATION METHOD. Shigeo Wakamatsu. Nippon Kinzoku Gakkaishi 24, 504-6(1960). (In Japanese)

Zinc in the presence of aluminum and tin was titrated with EDTA. To avoid the interference of aluminum and tin, NH_4F was used. The method was successfully applied to the determination of zinc in aluminum alloys. The procedure is as follows: Weigh a 2 g sample into a beaker and dissolve it in 30ml of 20% NaOH solution and 5ml of 30% H_2O_2. After boiling out the excess H_2O_2, add Na_2S solution, cool, dilute to volume in a 500-ml volumetric flask, and filter through a dry filter paper. Fe, Mn, Cu, Ni, Ti, Ca, Mg, etc., remain on the filter paper as hydrous oxides or sulfides. Pipet 10 to 50 ml of the filtrate into a beaker and dilute to about 70ml with water. Make it slightly acid with HCl and 3 g of NH_4F (to mask aluminum and tin) and 5ml of 50% CH_3COONH_4 solution. Adjust the solution to a pH of 5 to 6 with 1 to 1 NH_4OH. Heat at 70 to 80°C, add 3 to 4 drops of indicator (PAN), mix and titrate with 0.005M EDTA solution. Then back-titrate the excess EDTA with 0.005M $CuSO_4$ solution. (auth)

5969 SEDIMENTARY ROCK ANALYSIS BY CHARGED PARTICLE BOMBARDMENT. Robert F. Sippel and Everett D. Glover (Socony Mobil Oil Co., Inc., Dallas). Nuclear Instr. & Methods 9, 37-48(1960) Oct. (In English)

Rapid analytic techniques are urgently needed in geochemical investigations where hundreds of analyses are often required. Methods based on nuclear reactions in the light elements are described for the analysis of Li, Be, B, C, O, F, Na, Mg, Al, and P. The reactions were induced by proton, deuteron, and α particle beams from a 2-Mev Van de Graaff machine. The methods were evaluated for sensitivity and accuracy by analysis of synthetic specimens of known composition and of National Bureau of Standards analyzed rocks samples. Errors arising from stopping power variations were found to be small, in general not more than ±2%. These methods exactly complement the x-ray fluorescence technique, filling in the region inaccessible to the x-ray method. Used together, the methods can provide rapid instrumental analysis for virtually all elements in the periodic table to moderate sensitivity. Although sedimentary rocks were analyzed by this method, it

is applicable (with due consideration for stopping power) to many other types of materials. (auth)

5970 DETERMINATION OF VANADIUM IN STEELS AND FERROUS ALLOYS BY AMPEROMETRIC TITRATION USING TWO INDICATOR ELECTRODES. L. S. Studenskaya and O. A. Songina (Ural Scientific Research Inst. of Ferrous Metals, [USSR] and Kazakh State Univ., [USSR]). Zavodskaya Lab. 26, 1102-4(1960). (In Russian)

In the most extensively employed method of determining vanadium in ferrous alloys by amperometric titration with Mohr's salt, a permanganate solution must be added in excess to oxidize completely the vanadium; elimination of this excess complicates the process. Use of two electrodes with applied emf improved this condition; the permanganate and the trivalent iron were reduced in 2N H_2SO_4 solution, whereas the vanadium was not. A voltage of 0.5 to 1.0 volts was applied on the platinum electrodes. As titrating solution was added, the current was reduced and then stayed at a constant value while the vanadate was reduced by Mohr's salt. During this period the emf of the OH^-/Fe^{3+} couple formed was not sufficient to compensate the applied voltage. Beyond the end point, an Fe^{3+}/Fe^{2+} couple was formed, causing a rise in the emf. The titration could be repeated after reoxidizing the vanadium by permanganate. The end point derived from the amperometric curve was very sharp. (TTT)

5971 SPECTROCHEMICAL METHOD FOR DETERMINING IMPURITIES IN STRONTIUM AND BARIUM. M. A. Notkina and B. M. Dobkina (State Scientific Research and Development Inst. of the Rare Metal Industry, [USSR]). Zavodskaya Lab. 26, 1126-8(1960). (In Russian)

In order to determine metallic impurities in strontium and barium with a sensitivity better than 10^{-4}%, they were concentrated by complexing them with sodium diethyl-dithiocarbamate. The complexes of Bi, Fe, Cd, Mn, Cu, Pb, Sb, and Zn thus formed were extracted with chloroform from aqueous solutions acidified with HCl at pH ranging from 5 to 6. The extract was evaporated on carbon powder and was then subjected to spectral analysis in a carbon arc. The completeness of the extraction by this method was verified on synthetic mixtures containing 2 g of strontium or barium and known amounts of the previously mentioned metals in the concentration range of 10^{-4} to 10^{-5}%, using radioactive isotopes and spectrochemical methods. Good results were obtained with strontium and barium chlorides and carbonates. (TTT)

5972 RADIO-ACTIVATION ANALYSIS OF PURE MATERIALS AND THE PERSPECTIVES. V. I. Baranov, Yu. A. Surkov, G. M. Chernov, and Yu. V. Yakovlev. Zhur. Vsesoyuz. Khim. Obshchestva 5, 570-3(1960). (In Russian)

A 50 channel scintillation spectrometer with a 40 × 40 mm NaI(Tl) crystal and FEU-S photomultiplier was used in studies of admixtures in silicon. The resolving power of the γ spectrometer was 9%. The content of zinc was 1×10^{-5}%; arsenic, 1.2×10^{-7}; and gallium, 2 to 3×10^{-7}%. The γ spectra of pure activated silicon, thallium, and graphite were plotted and the results tabulated. The aspects and perspectives of activation methods are discussed. (R.V.J.)

5973 ACTIVATION ANALYSIS HANDBOOK. R. C. Koch. New York, Academic Press, 1960. 227p. $8.00.

Experimental data required for comparing alternate methods of activation analysis are compiled. Tabulated for each element are: data for activation analyses utilizing thermal and fast neutrons, charged particles, and photons; nuclear data for the reactions; nuclear data for other reactions potentially useful for activation analysis; nuclear data for possible interfering reactions; sensitivities for the more important neutron and charged particle activation reactions; and complete bibliographical referencing for all data. The main technical requirements for sample preparation, irradiation, monitoring, and radiometric assay are included. A glossary of 41 technical terms and analytic descriptions of nuclear reactions of interest are appended. (M.C.G.)

5974 METHODS OF DETERMINING U-235 IN FUELS USING A SCINTILLATION SPECTROMETER. Fred White (U. S. Atomic Energy Commission, Chicago). p.11-14 of "Institute of Nuclear Materials Management First Annual Meeting, Columbus, Ohio, June 20-21, 1960." Pittsburgh, Institute of Nuclear Materials Management, 1960.

An inexpensive method for determining U^{235} in fuels is described in which the 184-kev γ ray from U^{235} decay is measured in a scintillation spectrometer for both the sample and a standard. Three modifications of the method using different standards are outlined. With this method U^{235} may be determined with an accuracy as high as ±0.05% in round, concentric, and flat fuel-element configurations. (D.L.C.)

General Inorganic and Physical Chemistry

5975 (ANL-6267) DESIGN AND MASS TRANSFER STUDY FOR NEW MULTISTAGE FLUIDIZATION REACTOR (thesis). Kenneth Donald Williamson, Jr. (Argonne National Lab., Ill.). Dec. 1960. 159p. Contract W-31-109-eng-38. OTS.

Submitted to Pennsylvania State Univ.

A preliminary design enabling the downward transport of solids in multistage fluidization reactors is discussed, and a program to improve the preliminary plate design is reported. A three-stage 6-in. dia. column was constructed to obtain and correlate design and mass-transfer data. The preliminary plate design was improved by incorporation of a cover screen as a part of each plate which sandwiched the large nonfluidized beads, resulting in improved stability, and the use of internal vibration which permitted control of the fluidized solids bed depth on an individual stage basis. All of the design data were correlated into a set of five equations. From the equations it is possible to calculate the amount and size of nonfluidized beads that are necessary to achieve a given throughput rate of any material under any operating conditions. The experimental work is reported in the areas of development of a design correlation using a glass bead-air system, and investigation of column efficiency from mass-transfer runs involving the adsorption of water vapor from air by silica gel. (J.R.D.)

5976 (IDO-16629) METAL–WATER REACTIONS: RATES OF REACTION OF ALUMINUM AND ALUMINUM–URANIUM ALLOYS WITH WATER VAPOR AT ELEVATED TEMPERATURES. W. F. Zelezny (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Nov. 25, 1960. 55p. Contract AT(10-1)-205. OTS.

Considerations of reactor safety prompted a study of the reaction rates of molten aluminum and aluminum–uranium alloys with water vapor in order to assess the hazard of an explosively violent chemical reaction in the event of a nuclear incident involving the meltdown of a water-cooled reactor. An automatically recording thermobalance tech-

nique was used to obtain quantitative data for these reaction rates in the temperature range of 1500 to 2300°F over time periods of 2 hr. The reaction followed a linear rate law. The reaction rates for both aluminum and for the aluminum–uranium alloys rose with temperature to a maximum in the range of 1800 to 1900°F and decreased at higher temperatures. Calculations were made using the reaction rate data and certain simplifying, conservative assumptions of the rate of heating of a fine molten aluminum–uranium droplet of a nominal fuel composition (23.40 wt.% uranium) with water vapor at atmospheric pressure. These calculations indicated that under conditions of no heat loss a metal droplet 0.01 cm in diameter would rise in temperature from 1600 to 1700°F in a time period of slightly over 2 min. From this slow heating rate and the fact that the reaction rate declines at higher temperatures, it is concluded that the reaction of molten aluminum–uranium alloys with water vapor at near atmospheric pressures does not constitute an explosive hazard in the operation of nuclear reactors. The conclusions reached in the present work do not exclude the possibility of an explosively violent reaction between aluminum alloys and water brought together under other conditions; for example, when both the metal and the water are liquid. (auth)

5977 (JEN-79-DMA/I-13) EL CAMBIO DE ION Y SU RELACION CON LA INDUSTRIA. II. METODOS DE CALCULO DE INSTALACIONES. (Ion Exchange and Its Connection to Industry. II. Calculation Methods for Installations). A. Uriarte Hueda, B. Lopez Perez, and L. Gutierrez Jodra (Spain. Junta de Energiá Nuclear, Madrid). 1960. 31p.

A presentation is made of calculation methods for ion-exchange installations based on kinetic considerations and similarity with other unit operations. Factors to be experimentally obtained as well as difficulties which may occur in its determination are also given. Calculation procedures most commonly used in industry are enclosed and explain with numerical resolution of a problem of water demineralization. (auth)

5978 (K-1458) THERMODYNAMIC PROPERTIES OF GASEOUS URANIUM HEXAFLUORIDE. B. H. Parks and D. W. Burton (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 30, 1960. 44p. Contract W-7405-eng-26. OTS.

Tables of temperature dependent coefficients are presented for the computation of thermodynamic properties of gaseous UF_6 using equations which express the properties as expansions in powers of pressure. The various coefficients listed were computed in one degree increments for a temperature range of 500 to 999°R. This set of tables was computed by use of a virial equation representation for the equation of state and the thermodynamic properties were derived from this representation. (auth)

5979 (NAA-SR-Memo-5496) PHYSICAL PROPERTIES OF BENZENE–DIPHENYL MIXTURES. A. J. Bakaler (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 13, 1960. 35p.

Values calculated for benzene–diphenyl mixtures are presented as separate charts for each of the physical properties. The methods of estimating were either adapted from the literature or developed theoretically. It is urged that measurements be performed to obtain some actual values for the physical properties and critical properties. Data are appended on diffusion coefficients. (C.H.)

5980 (NP-9715) INFLAMMABILITE DU MAGNESIUM ET DE L'URANIUM CHAUFFES DANS DIVERS MILIEUX GAZEUX. (Combustibility of Magnesium and Uranium Heated in Different Gaseous Media). R. Darras, P. Baque, and D. Leclercq (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1959. 45p.

Magnesium, uranium, and some of their alloys' burning temperatures have been systematically determined in an air or carbon dioxide atmosphere, either dry or wet. Two different ways of heating have been used: either continuously raising the temperature or heating to and then maintaining a constant temperature. The results are clearly different in the two cases. Besides, if moisture has little effect on the magnesium burning temperatures in air, it does lower them by about 130 to 140°C in CO_2. The differences of sight between the burning of magnesium and uranium have been noticed; this leads to distinguish between an "ignition" and an "inflammation." (auth)

5981 (NYO-9068) ADSORPTION OF RADIOACTIVE GASES ON ACTIVATED CARBON. Richard Madey, J. J. Barker, M. R. Beebe, and T. E. Stephenson (Republic Aviation Corp., Farmingdale, N. Y.). Aug. 31, 1960. 57p. For Sanderson and Porter, [New York]. Contract AT(30-1)-2207. OTS.

An experiment was conducted to study the characteristics of a carbon adsorber bed receiving radioactive inert gas in a helium stream. Kr^{85} was used in the experiment because it can be readily produced and detected. The experiment was so designed that the adsorber saturation time is comparable to the mean Kr^{85} lifetime. The concentration of radioactive gas was of the order of 10^{-12} atom fraction. A model was developed in the work which can be used as a basis for the design of a minimum size bed for specified transmissions and to design an effectively infinite adsorber by choosing a mean propagation time larger than the mean lifetime for radioactive decay. The technique used in these experiments is useful in studying other radioactive gases. (J.R.D.)

5982 (ORNL-2896) PHASE EQUILIBRIA IN MOLTEN SALT BREEDER REACTOR FUELS. I. THE SYSTEM $LiF–BeF_2–UF_4–ThF_4$. C. F. Weaver, R. E. Thoma, H. Insley, and H. A. Friedman (Oak Ridge National Lab., Tenn.). Jan. 11, 1961. 60p. Contract W-7405-eng-26. OTS.

The phase equilibrium relations for the systems limiting the quaternary system $LiF–BeF_2–UF_4–ThF_4$ are described in detail, along with available information on the quaternary system itself. The implications of the extensive solid solutions in the limiting systems are discussed, and experimental information supporting the conclusions is presented. The optical properties, crystallographic properties, and x-ray diffraction patterns for the phases occurring in these systems are tabulated. Specific compositions of project interest to which references have been made in the ORNL literature are given special attention. Reference is made to literature reporting properties of these materials other than those discussed in this report. (auth)

5983 (TID-6892) THERMODYNAMIC PROPERTIES OF SOLUTIONS. Technical Progress Report No. 4. Frank T. Gucker (Indiana. Univ., Bloomington). Nov. 1, 1960. 5p. Contract AT(11-1)-504. OTS.

Work was continued with the twin-calorimeter thermal balance. This consists of a pair of closed calorimeters, which were spun from a gold-platinum alloy, equipped with a variable electrical resistance heater, and suspended within a submarine jacket in an adiabatic bath. Experiments were carried out at 5, 25, 45, 65, and 85°C on fine solutions

of KCl over the range 0.04m; on five solutions of NaBr at 25 and 45°C over the range from 0.2 to 1.6m; and on three solutions of NaBr at 65 and 85°C over the range from 0.2 to 0.7m. Work is reported on the vertical and horizontal interferometer. (W.L.H.)

5984 (TID-11146) HYDROGEN REDUCTION OF URANIUM OXIDES: A PHASE STUDY. K. J. Notz, C. W. Huntington, and W. Burkhardt (National Lead Co. of Ohio, Cincinnati). [1960]. 22p. OTS.

The successive phase changes which occur during the hydrogen reduction of uranium oxides were studied in situ by means of a controlled-atmosphere, x-ray diffractometer hot stage, at temperatures of 480 and 750°C. The phase sequence which occurs during the reduction of γ-UO_3, the most stable allotrope of UO_3, is as follows: γ-UO_3 (orthorhombic) $\xrightarrow{1}$ U_3O_8 (pseudo-hexagonal) $\xrightarrow{2}$ U_3O_8 (orthorhombic) $\xrightarrow{3}$ UO_{2+} (cubic) $\xrightarrow{4}$ UO_2 (cubic). The upper compositional limit of the nonstoichiometric phase, UO_{2+}, is greater at the higher reduction temperature, in agreement with the equilibrium phase diagram. When starting with U_3O_8, reactions 2, 3, and 4, as given above, were observed. In conjunction with this work, β-U_3O_8 was prepared and was found to revert endothermically to conventional U_3O_8 at about 130°C. (auth)

5985 (TID-11282) PROGRESS REPORT FOR PERIOD COVERING NOVEMBER 15, 1960—JANUARY 1, 1961. (Ionics, Inc., Cambridge, Mass.). Jan. 4, 1961. 11p. OTS.

Studies on the determination and separation of Ac^{227} are described. A decay scheme and analytical procedures are given. (W.D.M.)

5986 (AEC-tr-4208(p.57-65)) THE ADSORPTION OF URANYL SALTS ONTO SOLID ADSORBENTS. Yu. M. Tolmachev. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 55-63(1957).

A detailed study was undertaken of the adsorption of $UO_2(NO_3)_2$ from aqueous solutions onto activated carbon, silica gel, and a number of natural shales. (W.L.H.)

5987 (AEC-tr-4208(p.91-107)) AN INVESTIGATION OF THE OXIDATION-REDUCTION POTENTIAL OF THE SYSTEM U^{VI}/U^{IV}. A. M. Gurevich. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 88-103(1957).

The electromotive forces of the cells $^{-}Pt|UO_2SO_4$, $U(SO_4)_2$, $mH_2SO_4|\ mH_2SO_4$, Hg_2SO_4, Hg^{+} and $Hg^{+}|\ Hg_2SO_4|\ H_2SO_4\ |H_2$ were measured for m = 0.05, 0.508, 1.03, and 2.75 at a temperature of 25°C. The temperature coefficients of these cells were determined in the range from 0 to 50°C. The value of the normal redox potential of U^{VI}/U^{IV} was calculated as equal to 0.407 ± 0.003 v. The heat effect of the reaction $UO_2SO_4 + H_2 + H_2SO_4 = U(SO_4)_2 + 2H_2O$ was calculated as equal to 34,000 mcal. (W.L.H.)

5988 (AEC-tr-4303) THERMODYNAMIC ANALYSIS OF EQUILIBRIUM IN THE NIOBIUM—OXYGEN—CARBON SYSTEM. G. P. Shveikin (Shveykin). Translated from Trudy Inst. Khim., Akad. Nauk S.S.S.R., Ural Filial No. 2, 45-9(1958). 8p. JCL or LC.

A thermodynamic analysis of equilibrium in the C—O—Nb system is given. Conditions for the reduction of NbO_5 with C were shown to be functions of the composition of the intermediate reduction products. (C.J.G.)

5989 (AEC-tr-4304) INTERMEDIATE NIOBIUM COMPOUNDS IN THE REDUCTION OF NIOBIUM PENTOXIDE WITH CARBON. G. P. Shveikin (Shveykin). Translated from Trudy Inst. Khim., Akad. Nauk S.S.S.R., Ural Filial No. 2, 51-6(1958). 8p. JCL or LC.

The products of Nb_2O_5 reduction with carbon under vacuum at 1200°C were found to be NbO_2 and NbC_x. The interaction of NbO_2 and NbC_x were found to be the intermediate products. The possibility of formation of a niobium oxycarbide compound was discussed. (C.J.G.)

5990 (AEC-tr-4305) KINETICS OF NIOBIUM PENTOXIDE REDUCTION BY CARBON UNDER VACUUM. G. P. Shveikin (Sheykin). Translated from Trudy Inst. Khim., Akad. Nauk S.S.S.R., Ural Filial No. 2, 57-62(1958). 8p. JCL or LC.

The kinetics of NbO_5 reduction by acetylene black, coal tar pitch, and pitch coke was studied at 1000 to 3000°C. The reduction rate depended largely on the nature of carboniferous reductant and the reductant—NbO_5 mixture. Activation energy of NbO_5 reduction was 64,000 and 82,500 cal-g-mol for acetylene black and coal tar pitch, respectively. (C.J.G.)

5991 (AEC-tr-4383) KINETICS OF THE THERMAL DISSOCIATION OF HYDRATES OF ALUMINA. Charles Eyraud and Roland Goton. Translated by Myra Scott Feldman (Savannah River Lab.) from J. chim. phys. 51, 430-3 (1954). 6p. JCL.

Thermogravimetric measurements on hydrargillite and boehmite are reported. This method allows for continuous recording of weight loss as a function of time during the isothermal heating, thus giving data necessary to determine the kinetic properties of the reactions. Data on dissociation of these compounds are included. (J.R.D.)

5992 (CEA-tr-R-999) ETUDE DE LA SÉPARATION ÉLECTROCHIMIQUE DU BISMUTH DE SES SOLUTIONS DILUÉES À L'AIDE D'INDICATEURS RADIOACTIFS. [PART] I. (Study of the Electrochemical Separation of Bismuth from Dilute Solutions using Radioactive Tracers. [Part] I). D. M. Ziv and V. A. Ishina (Ichina). Translated into French by B. De Trezvinsky from Radiokhimiya 1, 185-95(1959). 25p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 9534.

5993 (CEA-tr-X-237) APPAREILLAGE POUR LA FILTRATION ET LA MESURE DES SUSPENSIONS RADIOACTIVES SUR DES FILTRES À MEMBRANES. (Apparatus for Filtration and Measurement of Radioactive Suspensions on Membrane Filters). R. Tykva and D. Gruenberger. Translated into French from Chem. listy 53, 527-8(1959). 4p.

For tracer studies of bacterial metabolism, a membrane filter is described which allows with maximum efficiency both filtration and measurement on one plate without moving it. (T.R.H.)

5994 (NP-tr-516) THE SIGNIFICANCE OF ELECTRIC BOUNDARY PHENOMENA WITH REGARD TO THE STABILITY OF HYDROPHOBIC DISPERSIONS. (De Beteekenis van de Electrische Grensvlakverschijnselen voor de Stabiliteit van Hydrophobe Dispersies). H. Eilers. Translated by R. G. Evan (U.K.A.E.A. Atomic Energy Research Establishment, Harwell) from Chem. Weekblad 33, 358-62(1936). 21p. (Includes original, 5p.) JCL.

Starting with Donnan's theory that the screening effect of the double layer is based on the prevention of the collision of particles owing to the kinetic energy by electrical repulsion, it follows that this screen effect cannot be expressed in terms of a potential. Under these conditions the assumption of a critical potential

at coagulation has little experimental support. The screening effect of the double layer must be expressed by a formula having the dimensions of work, of the following type: $A = C\ \zeta^2/K$. This equation was checked against the most important data given in the literature about the stability, the ζ potential, and the coagulation valves, and it was found that it describes the phenomena very well. (W.L.H.)

5995 (UCRL-Trans-609(L)) FOCUSING ION-EXCHANGE. VI. APPARATUS FOR THE CONTINUOUS SEPARATION OF METAL IONS (AND OTHER ELECTROLYTES). Ernst Schumacher and René Flüher. Translated from Helv. Chim. Acta 41, 1572-81(1958). 10p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 1981.

5996 (UCRL-Trans-628(L)) A STUDY OF CHLORIDE COMPLEXES OF RHODIUM BY THE ELECTROPHORESIS AND CHROMATOGRAPHY METHODS ON PAPER AND BY THE METHOD OF ION-EXCHANGE CHROMATOGRAPHY. M. Lederer. Translated from Zhur. Neorg. Khim. 3, 1799-1803(1958). 16p. JCL or LC.

Compounds forming in various solutions of rhodium chloride were studied, and a qualitative study of the stability of various chlorides of rhodium was carried out. It is shown that a freshly prepared solution of rhodium chloride, Na_3RhCl_6, contains $RhCl_6^{3-}$ ions, decomposes in storing, and forms another anion (possibly $Rh(H_2O)Cl_5^{2-}$) with a lower mobility, a neutral yellow compound (possibly $Rh(H_2O)_3Cl_3^0$), and traces of a cation compound (possibly, $Rh(H_2O)_4Cl_2^+$). The yellow solution of rhodium chloride obtained by dissolving rhodium(III) hydroxide in HCl contains rhodium only in the cation form, but decomposes in the course of several hours into six different complexes. Primary nonstable yellow chloride of rhodium has the mobility of approximately one-half of the charge and remains immobile at $R_f = 0$ in butanol-2N HCl. The separation of Rh-Pd or Rh-Pt by the method of paper chromatography with the application of butanol-HCl is not influenced by the type of the complex compound that is present in the solution because all complexes move together at a short distance from each other. (W.L.H.)

5997 REDUCTION OF CERIUM GROUP RARE-EARTH ELEMENTS ON MERCURY CATHODE. A. K. Lavrukhina, G. M. Kolesov, and Hsiao-en Tang (Vernadskii Inst. of Geochemistry and Analytical Chemistry, [USSR]). Doklady Akad. Nauk S.S.S.R. 134, 1406-9(1960) Oct. 21. (In Russian)

The optimum conditions for quantitative separation of samarium (up to 99.7%) were found; promethium and cerium (up to 97%) were deposited at a mercury cathode even with 10-fold concentrations of complex-forming addends. It is assumed that the promethium and cerium separation at a mercury cathode is conditioned by their 2+ state as an intermediate reduction state. (R.V.J.)

5998 OBSERVATIONS ON THE OCCURRENCE OF COPPER(I) FLUORIDE AS THE ACID-STABILIZED FLUOALUMINATE. Samual von Winbush and John D. Corbett (Ames Lab., Ames, Iowa). Iowa State J. Sci. 35, 251-4(1960) Nov. 15. (IS-148)

Although copper(I) fluoride is unknown in the solid state there is some published evidence for its formation in solution in molten CuF_2. Since the addition of halide acids was shown to stabilize lower oxidation states in similar systems, the $Cu-CuF_2$ reaction was studied in the presence of AlF_3. The diamagnetism of the very inert, reddish-purple copper aluminum fluoride obtained at 996° led to its formulation as a copper(I) fluoaluminate, possibly Cu_3AlF_6. (auth)

5999 PHOSPHATES AND POLYPHOSPHATES OF THE RARE EARTH ELEMENTS. III. CERIUM(III) TRIPOLYPHOSPHATES. E. Giesbrecht (Universidade de São Paulo, Brazil). J. Inorg. & Nuclear Chem. 15, 265-71 (1960) Oct. (In English)

The reaction between Ce(III) chloride and sodium triphosphate solutions was discussed. Evidences were obtained that Ce(III) and triphosphate ions form two insoluble compounds in which the ratios $Ce^{3+}:P_3O_{10}^{5-}$ are, respectively, 5:3 and 1:1. With excess triphosphate ions a stable solution is obtained. The characteristic absorption spectrum of Ce(III) chloride solutions is changed upon addition of excess sodium triphosphate as a result of the formation of relatively stable complex species. A new maximum between 300 and 304 mμ is observed. By the method of continuous variations, the complex is formed in the ratio $Ce^{3+}:P_3O_{10}^{5-} = 1:2$, in the pH range of 3.0 to 9.5. (auth)

6000 THE DENSITY OF MOLTEN METAL FLUORIDES IN THE RANGE OF 1600-2500°K. A. D. Kirshenbaum, J. A. Cahill, and C. S. Stokes (Temple Univ., Philadelphia). J. Inorg. & Nuclear Chem. 15, 297-304 (1960) Oct. (In English)

Using a graphite crucible and a tungsten sinker, the liquid densities of the alkaline-earth and two rare-earth fluorides were determined by the immersed-sinker method at temperatures of 1600 to 2500°K. The molar volumes and thermal coefficients of expansion were calculated from the liquid densities and were correlated with those of the alkali-metal fluorides. The liquid-molar volumes of the alkaline-earth fluorides exhibit a linear relationship when plotted against the period in the periodic table. (auth)

6001 SOME INVESTIGATIONS IN THE ZIRCONIUM TETRAFLUORIDE–WATER SYSTEM. T. N. Waters (Atomic Energy Research Establishment, Harwell, Berks, England). J. Inorg. & Nuclear Chem. 15, 320-8(1960) Oct. (In English)

A characteristic property of the fluorides of the heavier metals is the ease with which they form hydrates. For example, D'Eye and his co-workers characterized six hydrates of thorium tetrafluoride and two hydrates of zirconium, uranium, and plutonium tetrafluoride. Thorium tetrafluoride appears to form two sets of related hydrates; the first by precipitation of the fluoride from a Th^{4+} solution and the second by hydration of anhydrous tetrafluoride. Their formation and interrelationships probably depend as much on the ability of fluorine and oxygen to form hydrogen bonds as on the occurrence of structural voids due to the tendency of fluorine to form network structures. Hydrogen bonds are present in $CuF_2,2H_2O$ for example, whereas in uranium tetrafluoride excess fluorine can be accommodated in lattice voids. (auth)

6002 THE CRYSTAL STRUCTURE OF CESIUM BIURANYL TRISULPHATE, $Cs_2(UO_2)_2(SO_4)_3$. M. Ross (Univ. of Maryland, College Park and Geological Survey, Washington, D. C.) and H. T. Evans, Jr. (Geological Survey, Washington, D. C.). J. Inorg. & Nuclear Chem. 15, 338-51(1960) Oct. (In English)

The crystal structure of the new compound $Cs_2(UO_2)_2(SO_4)_3$ was determined by x-ray diffraction methods. The compound is tetragonal, space group $P\bar{4}2_1m$ (D_{2d}^3), with $a = 9.62 \pm 0.02$, $c = 8.13 \pm 0.01$ A, and $Z = 2$; s.g. (calc.) = 4.80 ± 0.03, s.g. (obs.) = 4.74 ± 0.05. The compound forms

plates parallel to (001) bounded by the form (110). Intensity data were obtained from Buerger precession photographs of the (hk0) and (0kl) reciprocal lattice nets. No corrections for absorption were made. The co-ordinates of the uranium and cesium atoms were obtained by interpretation of the Patterson projections normal to (001) and (100) and a plausible structure was derived from electron density projections. The final parameters of the structure were determined from subtraction electron density maps, least squares analysis of the structure factors, and spatial considerations. The compound has a layer structure consisting of $[(UO_2)_2(SO_4)_3]_n^{2n-}$ sheets parallel to (001), tied together by cesium ions. The UO_2^{2+} group is co-ordinated by five sulfate oxygens which form a nearly plane pentagon approximately normal to the uranyl axis. The Cs_2 atom is co-ordinated by twelve oxygen atoms and the Cs_1 atom by eight oxygen atoms. X-ray and optical data are given for the compound $Rb_2UO_2(SO_4)_2 \cdot 2H_2O$. (auth)

6003 PREPARATION AND CRYSTALLOGRAPHIC STUDY OF SOME NEW RARE EARTH COMPOUNDS. L. Brixner (E. I. du Pont de Nemours, Wilmington, Del.). J. Inorg. & Nuclear Chem. 15, 352-5(1960) Oct. (In English)

With the exception of element 61, the tervalent rare-earth ions, as well as those of scandium and yttrium, have been incorporated in the formula type $BaNb_{0.5}Me_{0.5}O_3$ (Me = rare-earth metal, scandium, and yttrium). All compounds crystallize in the undistorted perovskite structure, except for $BaLa_{0.5}Nb_{0.5}O_3$, which is tetragonally distorted at room temperature but cubic at 800°C. Lattice parameters, densities, and dielectric properties were determined and are summarized. (auth)

6004 ION EXCHANGE BEHAVIOUR OF THE ACTINIDE ELEMENTS IN HYDROCHLORIC ACID. G. R. Choppin (Florida State Univ., Tallahassee) and A. Chatham-Strode (Oak Ridge National Lab., Tenn.). J. Inorg. & Nuclear Chem. 15, 377-83(1960) Oct. (In English)

In confirmation of an earlier explanation for the elution pattern seen in this system, a greater range of actinide elements was studied in several different batches of Dowex-50. These results indicate that there is insufficient data at present to accept the earlier explanation as any more probable than several other possible suggestions. (auth)

6005 MECHANISM AND KINETICS OF THE UNCATALYZED MERCURY(I)–CERIUM(IV) REACTION. W. H. McCurdy, Jr. (Univ. of Delaware, Newark) and G. G. Guilbault (Princeton Univ., N. J.). J. Phys. Chem. 64, 1825-7(1960) Dec.

The rate of oxidation of mercury(I) perchlorate by cerium(IV) sulfate in perchloric acid media was found to follow the rate expression: $-d[Ce(IV)]/dt = 8.5\,[Ce(IV)]\,[Hg_2^{2+}]$ at 50.0°, in which the concentrations are moles per liter and time is in minutes. The dependence of the reaction rate on sulfuric and perchloric acids is discussed in terms of the cerium(IV) species in solution. A reaction mechanism is proposed in which the rate-determining step is believed to involve concomitant breaking of the $(Hg\text{-}Hg)^{2+}$ bond and electron transfer. The activation energy of this reaction was found to be 14.4 kcal/mole. (auth)

6006 THE COMPARATIVE ROLES OF OXYGEN AND INHIBITORS IN THE PASSIVATION OF IRON. II. THE PERTECHNETATE ION. G. H. Cartledge (Oak Ridge National Lab., Tenn.). J. Phys. Chem. 64, 1882-7(1960) Dec.

Galvanostatic and potentiostatic polarizations of passive iron electrodes were made in solutions of a phthalate or pertechnetate and mixtures of them. By measuring the polarizations both in oxygen and in essentially oxygen-free helium the relative contributions of oxygen and the reducible inhibitor to the total cathodic current were determined. An acceleration of the cathodic processes by the reduction product of the pertechnetate ion was demonstrated. It was shown that reduction of oxygen is the principal cathodic process at passive potentials. (auth)

6007 THE ISOTOPIC EXCHANGE OF FLUOROBORIC ACID WITH HYDROFLUORIC ACID. M. Anbar and S. Guttmann (Weizmann Inst. of Science, Rehovoth, Israel). J. Phys. Chem. 64, 1896-9(1960) Dec.

The isotopic exchange rate of fluorine between fluoroboric and hydrofluoric acids was investigated. The rate of exchange $R = 4.5 \times 10^4\, e^{-24,700/RT}\, [BF_4^-][H^+]$ liters $mole^{-1}$ sec^{-1}. The exchange was found to proceed via $HBF_4 \rightleftharpoons HF + BF_3$, $BF_3 + H_2O \rightleftharpoons HBF_3OH$ followed by rapid isotopic equilibration between BF_3OH^- and HF. The mechanism of exchange was found identical with the mechanism of hydrolysis in acid medium. The nonacid hydrolysis of BF_4^- proceeds by a Sn1 mechanism with a rate constant $k = 8 \times 10^5\, e^{-15,500/RT}$ sec^{-1}. (auth)

6008 MISCIBILITY OF METALS WITH SALTS. V. THE RUBIDIUM–RUBIDIUM HALIDE SYSTEMS. M. A. Bredig and J. W. Johnson (Oak Ridge National Lab., Tenn.). J. Phys. Chem. 64, 1899-1900(1960) Dec.

The miscibility of rubidium metal with its molten halides is found to be large and, as expected, intermediate between that of potassium and cesium with their halides. A miscibility gap is absent in the RbBr–Rb system; like the other alkali metal-bromide systems, it deviates less from ideality than the corresponding chloride and iodide systems. (auth)

6009 THE MUTUAL DIFFUSION OF LIGHT AND HEAVY WATER. L. G. Longsworth (Rockefeller Inst., New York). J. Phys. Chem. 64, 1914-17(1960) Dec.

With the aid of a new diffusion cell and Rayleigh interferometry the mutual diffusion of light and heavy water was measured at 5, 25, and 45° over the entire range of composition. Paralleling rather closely the fluidity of H_2O–D_2O mixtures, and also the chloride ion mobility therein, the diffusion coefficient exhibits small negative departures from a linear decrease with increasing mole fraction of D_2O. The effect of temperature on diffusion in this sytem is compared with that of large solutes in aqueous solution. (auth)

6010 ABSORPTION SPECTRA OF URANIUM(III) AND URANIUM(IV) IN $DClO_4$ SOLUTION. Donald Cohen and W. T. Carnall (Argonne National Lab., Ill.). J. Phys. Chem. 64, 1933-6(1960) Dec.

The absorption spectra of U(III) and U(IV) in $DClO_4$ were observed at 0.2 to 2.6 μ. Solutions of a pure valence state were prepared and maintained by electrolytic reduction in a combination electrolysis-absorption cell. Several new bands were discovered in the ultraviolet and near infrared regions, and their positions as well as those of the other bands in the spectra are compared with the energy levels calculated from theory. (auth)

6011 COAGULATION OF SILVER HALIDE SOLS BY THORIUM NITRATE IN THE PRESENCE OF POTASSIUM NITRATE AND POTASSIUM SULFATE. K. F. Schulz and

E. Matijević (Univ. of Zagreb and Clarkson Coll., Potsdam, N. Y.). Kolloid-Z. 168, 143-50(1960). (In English)

When silver iodide, bromide, and chloride sols in statu nascendi are coagulated by thorium nitrate in the presence of potassium nitrate, three coagulation maxima appear. Two are identical with maxima found in absence of KNO_3. The new maximum appears in the stability region of recharged sols. It is believed that this maximum is also caused by the coagulation of recharged silver halide sols by nitrate ions. Appearance of two nitrate coagulation maxima is explained by different charge densities of sol particles at various concentrations of $Th(NO_3)_4$ where they are formed. The new maximum indicates a lower charge density of sol particles. The possibility that the new maximum could have been caused by ionic complex species between thorium and nitrate ions has been rejected for data are available that the equilibrium constant for such complexes is small. In the presence of K_2SO_4 the coagulation effects of thorium nitrate on silver halide sols are markedly different. In acidified solutions only one coagulation maximum appears at rather high thorium nitrate concentrations [$\sim 10^{-3}$ N $Th(NO_3)_4$], and the sol remains negatively charged [up to $\sim 10^{-2}$ N $Th(NO_3)_4$]. This is explained by complex formation of thorium-ions and sulfate ions whereby ionic species of lower charge are formed, which exert a weaker coagulation effect. In neutral solutions another maximum at lower concentration of $Th(NO_3)_4$ is formed which appears to be the usual coagulation maximum produced by hydrolyzed thorium ions. The antagonistic effects of the salt pair $Th(NO_3)_4$-K_2SO_4 upon the coagulation of silver halides was discussed and it is concluded that the large effects repeatedly reported can be explained not by simple electrostatic effects of ions in solution but rather by the formation of complexes between Th- and SO_4-ions. (auth)

6012 THORIUM OXIDE SUSPENSIONS. D. G. Thomas E. L. Compere, and J. P. McBride (Oak Ridge National Lab., Tenn.). Nucleonics 18, No. 12, 104, 106, 110(1960) Dec.

Heat-transfer and fluid-flow characteristics of ThO_2 aqueous slurries were determined. Preparation processes that produce slurry particles which have optimum size (~3μ) and high wear resistance were developed. Serious corrosion effects appeared to be the result of at least one of the following factors: high velocity with some type of flow separation or eddies, many large particles in the slurry, and unfavorable atmosphere or aqueous environment leading to water corrosion effects. The corrosion-erosion attack was of at least three types: flow abrasion, eddy erosion, and impingement attack. Methods of calculating turbulent-flow friction factors were derived. (M.C.G.)

6013 PREPARATION OF HIGH DENSITY UO_2. (to United States Atomic Energy Commission). British Patent 852,979. Nov. 2, 1960.

UO_2 particles of high density, low surface area, and low chemical reactivity may be prepared from UF_6 in the following way: a ≥10M NH_3 solution is added to an aqueous solution of UO_2F_2 containing ≥5 wt. % uranium, the precipitate is separated and calcined to U_3O_8 at 700 to 800°C, and the U_3O_8 is contacted with CO + CO_2 at 1600 to 1900°C to form the final UO_2 product, which has a tap density of 6.0 to 5.5 g/cm³ and an area of 0.03 m²/g. The conditions involved in this method are given and illustrated with one example. (D.L.C.)

Radiation Chemistry and Radiochemistry

6014 (ORNL-2970) LOW-TEMPERATURE THERMOLUMINESCENCE OF THE GAMMA-IRRADIATED AMINO ACIDS AND PROTEINS. James G. Carter (Oak Ridge National Lab., Tenn.). Nov. 30, 1960. 65p. Contract W-7405-eng-26. OTS.

Radiation-induced thermoluminescence was studied for four proteins and twenty-three L-amino acid preparations. The powdered crystalline samples were irradiated at liquid-nitrogen temperature and subsequently warmed to room temperature. Glow curves—plots of intensity of light emission versus temperature—are presented for these preparations. The intensities of peaks in the glow curves and the temperatures at which they occur were studied and it was concluded that the glow curves from proteins are not the sum of the glow curves of the constituent amino acids in their isolated crystalline form, and that chemical composition exerts the greatest influence on the thermoluminescence from amino acids. It was also concluded that the crystalline system to which an amino acid belongs seems to play a negligible role in determining the nature of the glow curves, and small changes in the level of purity may exert a relatively strong influence on the thermoluminescence from some amino acids. (auth)

6015 (TID-7591(p.78-80)) THE REMOVAL OF ALPHA CONTAMINATION FROM LANTHANUM BY ION EXCHANGE. L. B. Farabee (Oak Ridge National Lab., Tenn.).

Procedures are described for the production of large quantities of lanthanum, free of α contamination, by separation of the lanthanum from actinium α impurities. The separation is accomplished on a cation-exchange resin column by using citric acid at a pH of 3.2 to elute the lanthanum from the actinium. Since there is no growth of α radioactivity in the lanthanum, large supplies can be prepared and stored for future use. Lanthanum is used as a precipitating agent in the analysis of urine for plutonium and the presence of α contamination has always been an obnoxious problem. (C.H.)

6016 (UCRL-9208(p.27-33)) THE RADIATION DECOMPOSITION OF $[(CH_3)_3NCH_2C^{14}H_2OH]$ $^+Cl^-$. Margaret A. Smith and Richard M. Lemmon (California. Univ., Berkeley. Lawrence Radiation Lab.).

Recent work led to proposals for the mechanism of the radiation decomposition of crystalline choline chloride. These proposals assume the transient existence of a radical with a structure similar to: $CH_2 \cdot CH_2OH$, such a structure being based on the ESR spectra obtained from selectively deuterated, irradiated choline chloride. It is also quite possible that the radical might assume an ethylene oxide structure since it is known that the unpaired electron is shared equally by the two carbon atoms. Such a symmetrical intermediate would mean that the two carbon atoms initially present in the ethanol group of choline would be indistinguishable in the acetaldehyde that appears as a result of the radiation decomposition. To test this possibility choline chloride labeled with C^{14} in the carbinol carbon atom was synthesized, and the distribution of C^{14} in the two carbon atoms of the radiation-produced acetaldehyde was observed. Two samples of irradiated choline chloride were analyzed. The results of these experiments demonstrate that there is no symmetrical two-carbon species in the mechanism yielding acetaldehyde from irra-

diated crystalline choline chloride. The carbinol carbon atom of choline chloride is the aldehydic carbon in the acetaldehyde. (auth)

6017 (WADD-TR-60-668) THE RADIATION CHEMISTRY OF CHLOROFORM SYSTEMS. Gabriel Stein, M. Ottolenghi, and I. Eliezer (Hebrew Univ., Jerusalem). Feb. 29, 1960. 24p. Project No. 7360. Contract AF61(052)-224. OTS.

A dosimeter based on solutions of biallyl in chloroform is developed. The radiation chemistry of pure H_2O- and oxygen-free chloroform is investigated, and all products are identified. A reaction mechanism is derived. (auth)

6018 (DEG-Inf. Ser.-53) FUNDAMENTAL PROBLEMS OF THE RADIOLYSIS OF AQUEOUS SOLUTIONS. M. Haissinsky. Translated by J. C. Ruckman from Inds. atomiques 3, Nos. 3/4, 37-46(1959). 15p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 14373.

6019 REACTION OF DL-THREONINE WITH RECOIL TRITIUM ATOMS. Yoshishige Sato, Teruhiko Meshi, and Tadao Takahashi (Tanabe Seiyaku Co., Ltd., Osaka). Bull. Chem. Soc. Japan 33, 1146(1960) Aug. (In English)

Investigations of the preparation of tritium-labeled organic compounds were previously carried out using recoil tritium atoms from the $Li^6(n,\alpha)H^3$ reaction. The results are given of similar experiments using DL-threonine. In this experiment the allo-isomer was found. A mixture of DL-threonine and lithium carbonate was irradiated with thermal neutrons at a flux of 2.5×10^{11} neutrons/cm^2/sec. The irradiated mixture was dissolved in water and processed to yield 800 mg of white crystals with a specific activity of 0.113 μc/mg. Paper chromatography of the crystals showed three spots on spraying with ninhydrine. R_f values of the spots were identical with those obtained by pure DL-threonine (0.24), allo-threonine (0.17), and glycine (0.05), respectively. (B.O.G.)

6020 NON-IODIDE RADIOACTIVITY IN COMMERCIAL SOLUTIONS OF SODIUM RADIO-IODIDE (I^{131}). C. S. Ahn and I. N. Rosenberg (Boston City Hospital and Boston Univ. School of Medicine). Endocrinology 68, 50-61(1961) Jan.

Some samples of commercially available solutions of sodium radioiodide (I^{131}) were found to contain radioactive iodine in a form electrophoretically and chromatographically different from iodide. This material (designated "S") was anionic, was not affected by reducing agents in neutral or alkaline solution and its radioactivity could be converted almost completely to iodide by heating or by acidifying the solution. Errors in the estimation of thyroidal uptake of iodide could conceivably occur under certain circumstances if tracer solutions containing appreciable "S" were used. In the more recently available solutions of sodium radioiodide (I^{131}), some of which contained cysteine hydrochloride, only iodide-I^{131} has been detected. (auth)

6021 THORIUM-234 "COW". J. van R. Smit (National Chemical Research Labs., Pretoria). J. Chem. Educ. 37, 650(1960) Dec.

Methods used for the separation of Th^{234} from U^{238} are described. Except for large-scale work, it is considered that ether extraction is the simplest and quickest. In ether extraction small amounts of uranium are extracted with the Th^{234} activity. Methods available for the separation of uranium are outlined. (B.O.G.)

6022 RADIOCHEMICAL STUDIES OF FISSION PRODUCT LANTHANUM AND LANTHANIDES. I. ISOLATION OF TRACE LANTHANIDES USING NON-ISOTOPIC CARRIER AND DROP ELUTION TECHNIQUE. J. Alstad and A. C. Pappas (Univ. of Oslo). J. Inorg. & Nuclear Chem. 15, 222-36(1960) Oct. (In English)

The use of lanthanum as a common carrier for all lanthanides was studied. The results show that lanthanum under the given conditions carries trace lanthanum and lanthanides to the same extent. On this basis a radiochemical method for the determination of nuclear reaction yields was developed. Lanthanum is used as carrier in fluoride and hydroxide precipitations for group isolation of all the lanthanides that are formed. A further group purification is obtained by an anion exchange step. The elements are thereafter separated from each other by cation exchange chromatography using ammonium lactate as eluant. The use of the nonisotopic carrier makes possible yield measurements of short-lived nuclides. The time needed is about one-tenth of that of previous methods. The fission yields obtained show a high degree of reliability. This is partly due to the weightless sources obtained, which considerably simplify measurements of absolute disintegration rates. Only a single chemical yield determination, that of the lanthanum, is sufficient to determine the recovery of all the lanthanides concerned. Using this method, improved half lives are given for some nuclides in the lanthanum series: 3.87 ± 0.04 hr La^{141}, 5.88 ± 0.10 hr Pr^{145}, 11.14 ± 0.06 day Nd^{147}, and 9.1 ± 0.7 hr Sm^{156}. Two new neutron-rich isotopes of terbium were found to occur among the products of high-energy induced fission with half lives 6.5 ± 0.3 hr and 23 ± 2 hr. The probable mass numbers, based on fission-yield measurements, are 163 and 164, respectively. (auth)

6023 A NOVEL METHOD FOR THE PREPARATION OF CARRIER-FREE LEAD-212. Milton Kahn and A. L. Langhorst (Univ. of New Mexico, Albuquerque). J. Inorg. & Nuclear Chem. 15, 384-5(1960) Oct. (In English). (SCDC-995)

A procedure is described for preparing carrier-free Pb^{212} from a nitric acid solution of thorium nitrate that is refluxed in a modified Soxhlet extractor. The thoron escaping the boiling solution is carried into the upper part of the apparatus where the water vapor condenses; the thoron is collected there and decays to Po^{216}, which decays to Pb^{212}; the Pb^{212} is subsequently washed onto and retained by the resin column, which replaced the extraction thimble in the apparatus. The lead activity is eluted from the resin and removed from the condenser walls with 1N hydrochloric acid. The results of several experiments are summarized as: dependence of recovery of reflux time; effect of HNO_3 concentration on recovery; and dependence of recovery on solution volume. The yield was essentially independent of reflux times less than 15 hr, decreased slightly with increase in volume of solution, and was only slightly dependent on HNO_3 concentration; the yield was highest (~45%) at a HNO_3 concentration of 1M. (B.O.G.)

6024 CHEMICAL BEHAVIOUR OF PHOSPHORUS-32 RECOILS IN CRYSTALLINE DISODIUM HYDROGEN PHOSPHATE. L. Lindner and G. Harbottle (Brookhaven National Lab., Upton, N. Y.). J. Inorg. & Nuclear Chem. 15, 386-7(1960) Oct. (In English)

A study was made of P^{32} recoil reactions in crystalline systems as a function of radiation and thermal environment, i.e., temperature of bombardment, flux, neutron to

γ-ray ratio, annealing conditions, and crystalline environment. Anhydrous Na_2HPO_4 was bombarded at dry ice temperature at 2×10^{12} neutrons/cm^2/sec, cadmium ratio ~40. The salt was dissolved in ice-cold 0.1M lactic acid, and 5 to 10 λ analyzed by electrophoresis on Whatman 3MM moistened with 0.1M lactic acid, at a voltage gradient of 80 volts/cm for ~1 hr. The per cent activity and the identity of the peaks were determined from the given histogram. When these irradiation conditions were varied by increasing the ambient temperature of bombardment, the present results began to approach those of Sellers et al. These changes confirmed the belief that annealing during and/or after bombardment may have influenced their results. It is believed that their conclusion concerning the extensive disruption of the P–O or the P–O–P linkages is unjustified, and that the maximum probability of nonbond-rupture in crystalline phosphates is no greater than 9.3%, as observed for the orthophosphate, and may well be lower. (B.O.G.)

6025 COMPARISON OF $^{18}O/^{16}O$ AND $^{17}O/^{16}O$ ISOTOPE EFFECTS IN SOME REACTIONS OF HYDROGEN PEROXIDE. J. A. Mattern (Univ. of Buffalo). J. Inorg. & Nuclear Chem. 15, 388-9(1960) Oct. (In English)

A search was made for an isotope effect in oxygen similar to that found for carbon, since O^{17} and C^{13} have nuclear magnetic moments and O^{16} and O^{18} do not. Reactions chosen for the study were some oxidations and reductions of hydrogen peroxide. The method used was that of Cahill and Taube, except that O^{17}/O^{16} and O^{18}/O^{16} ratios were measured in the same sample. The results are tabulated with fractionation factors reported by Cahill and Taube using Fe^{2+} and I^- reagents in reduction, and Cl_2 and $(MnO_4)^-$ reagents for oxidation. The most likely sources of error were (1) interference by catalytic decomposition and (2) incorrect determination of the H_2O_2 fraction used. In the oxidation systems the isotope effect is so small that a great deal of significance cannot be attached to the values obtained. Since the ratios in all cases are close to 2, there is no indication of a difference between the O^{18}/O^{16} and O^{17}/O^{16} isotope effect that cannot be explained by mass differences. Thus, if there is any catalytic effect due to O^{17}, it is too small to be observed in the system studied. (B.O.G.)

6026 THE RADIATION CHEMISTRY OF AQUEOUS PERMANGANATE SOLUTIONS. Malcolm Daniels (Argonne National Lab., Ill.). J. Phys. Chem. 64, 1839-47 (1960) Dec.

The reduction of permanganate solutions, induced by Co^{60} γ rays, was investigated in acid, neutral, and alkaline solution. In 0.8 N H_2SO_4 the major products are MnO_2 and O_2, and yields were determined over a wide range of radiation intensity and permanganate concentration. A chain reaction was found and the over-all rate of reduction can be represented by $G(-MnO_4^-) = G_0 + k_1(MnO_4^-)^{1/2} + k_2(MnO_4^-/I)^{1/2}$, where $G_0 = 2.3$, $k_1 = 10$, and $k_2 = 0.8 \times 10^{11}$ (G is defined as molecules per 100 ev, concentration units are M, and intensity units are electron volts per liter per minute). An explanation is offered involving intermediate formation of 0 atoms and MnO_5^-. Yields of hydrogen gas ("molecular yield") were determined at various permanganate concentrations, and reactions of solutions saturated with H_2 were investigated. Explanation in terms of MnO_5^- is suggested. At pH 5.6 colloidal Mn(IV) is produced but in 0.5 M OH^-, manganate is the initial product. In both neutral and alkaline solution curves of product yield vs. dose exhibit decrease in slope when the product accumulates; this is attributed to reoxidizing reactions of OH radical with the products. (auth)

6027 ISOTOPE EFFECT IN RECOIL TRITIUM ABSTRACTION REACTIONS WITH METHANE. J. K. Lee, Burdon Musgrave, and F. S. Rowland (Univ. of Kansas, Lawrence). J. Phys. Chem. 64, 1950-1(1960) Dec.

An isotopic preference for the abstraction of hydrogen atoms rather than deuterium atoms from CH_4 has been shown by high-energy tritium atoms. This preference was demonstrated intramolecularly in CH_2D_2 and intermolecularly in CH_4-CD_4 mixtures. Mixtures of purified He^3 with CH_2D_2 and with mixtures of CD_4 and CH_4 were separately sealed in Pyrex and irradiated at 3×10^9 neutrons/cm^{-2}/sec^{-1}. Aliquots of each sample were separated and analyzed for radioactive components. The results are tabulated giving pressures of the gases of the samples and the specific activities for various ratios: HT/DT and $\Sigma(HT + DT)/\Sigma(CH_2DT + CHD_2T)$ for $He^3-CH_2D_2$ mixtures, and (HT/DT), (HT/DT) + (CH_4/CD_4), and $\Sigma(HT + DT)/\Sigma(CH_3T + CD_3T)$ for $He^3-CH_4-CD_4$ mixtures. The estimated error of the determinations of the HT/DT ratio is ±0.02 to 0.07. (B.O.G.)

6028 FORMATION OF ACTIVATED HYDROGEN PEROXIDE BY IRRADIATION OF WATER WITH α-RAYS. P. Alexander and D. Rosen (Royal Cancer Hospital, London). Nature 188, 574-5(1960) Nov. 12.

When water is exposed to ionizing radiations the radicals H and OH are produced and these can combine either with each other to give the molecular products H_2 and H_2O_2, or with solutes. In regions of high-energy loss (such as α-particle tracks) the local concentration of radicals is sufficiently high for combination between them to occur sooner than reaction with the solute. Consequently, while the chemical effects of x rays on aqueous solutions are brought about chiefly by radical reactions, those of α rays are chiefly by molecular reactions. While studying the effects of ionizing radiations on protein solutions, it was noted that polonium α rays gave rise to changes which were qualitatively different from those brought about by x rays, but which could not be obtained by treatment with hydrogen peroxide at a final concentration of 0.6M, a thousand times greater than that produced by the α rays in the water. To elucidate this phenomenon a comparison was made of the effects of x and α rays on amino acid solutions (tryptophan). The α radiation was delivered at 20,000 to 45,000 rads/hr (G = 5.6) and the x radiation at 6640 rads/min (G = 15.6). Results show that α irradiation of water yields a highly oxidizing product which reacts with particular readiness with the indole ring of tryptophan, as does ozone. It is suggested that the product is H_2O_2, formed by the combination of two OH radicals either in an excited state or in a reactive isomeric state. Since it reacts with a substrate at a concentration of 10^{-4}M, the lifetime of this intermediate must be at least 10^{-5} sec, eliminating the possibility that a singlet state is involved. Although no evidence establishing a triplet state of H_2O_2 was found, the existence of this state is probable on general grounds. (B.O.G.)

6029 ORGANIC-IRRADIATION YIELDS. George Odian (Radiation Applications Inc., Long Island City, N. Y.). Nucleonics 18, No. 11, 185(1960) Nov.

Data on radioinduced polymerization and graft polymerization presented in tabular form for various organic monomers and polymers include dose rate, film thickness, and % graft or % conversion per megarad. (M.C.G.)

6030 EXTRACTION OF TRITIUM PRESENT IN HELIUM-3. M. J. W. Elliott (Atomic Energy Research Establishment, Harwell, Berks, England). Rev. Sci. Instr. 31, 1218-22(1960) Nov.

The concentration of H^3 present in 10 liters of He^3 was reduced to the order of 10^{-11} by absorption in pyrophoric uranium. This purity was required in order that the resolution of a gridded ionization chamber neutron spectrometer containing the He^3 should not be adversely affected. Details of the purification system and method are given. The assay of the H^3 by introduction of samples of the He^3 into Geiger counters is discussed. (auth)

6031 LIQUID-PHASE OXYGEN OXIDATION OF p-XYLENE AND p-TOLUIC ACID UNDER γ RADIATION. Juichi Imamura and Nobuto Ohta. Tokyo Kogyo Shikensho Hokoku 55, 346-50(1960) Sept. (In Japanese)

The effects of γ radiation on the liquid-phase oxygen oxidation of p-xylene and p-toluic acid were studied, comparing with that of fluoresent illumination or no illumination (i.e. the dark state). In these studies the usual method of bubbling oxygen gas into the reaction liquid in a tubular glass reactor under atmospheric pressure was used, and Co^{60} of 2,000 curies and 220 curies were used as the γ-ray sources. In the oxidation of p-xylene, the initial rate of formation of hydroperoxide in the case of γ-ray radiation as well as in that of fluorescent illumination was about two times the rate for no illumination. But the γ radiation and the fluorescent illumination could not get the reaction to go over 4 to 5 mole % of the rate of producing hydroperoxide plus acids, which was similarly recognized to be the limit in the case of no illumination, perhaps because of formation of inhibitors during the oxidation. In these three cases, the reaction products showed similar compositions and contained no terephthalic acid. In the oxidation of p-toluic acid, some promoting effects of γ radiation were recognized in some conditions, but they were not so large that the radiation-oxidation method seemed to be as attractive as the method of synthesizing terephthalic acid. (auth)

6032 ISOTOPE EFFECTS ON REACTION RATES. Lars Melander. Modern Concepts in Chemistry. New York, The Ronald Press Company, 1960. 187p. $6.00.

A treatment is presented on the main principles of kinetic isotope effects. Chapters cover rate-constant ratios from theory and experimental data, primary and secondary hydrogen isotope effects, carbon isotope effects, reaction mechanisms, and isotope effects with elements heavier than carbon. (D.L.C.)

6033 IMPROVED HYDROCARBON RADIOCHEMICAL CONVERSION PROCESS. (to Esso Research and Engineering Co.). British Patent 851,541. Oct. 19, 1960.

A radiochemical process for producing lubricating oils or lubricating oil additives is outlined in which liquid paraffins of 2 to 20 carbon atoms per molecule are exposed to high-energy radiation (neutrons or γ rays) in such a manner that the radiation intensity is decreased with time. For example, the hydrocarbons may be exposed to a radiation intensity of $> 4 \times 10^7$ r/hr until the energy absorbed reaches 80 Btu/lb, after which the intensity is reduced to 4×10^6 to 4×10^7 r/hr. When the dose reaches 100 Btu/lb, the intensity is further reduced to 10^4 to 4×10^6 r/hr and the irradiation continued to a total dose ≥ 120 Btu/lb. The radiation intensity variation can be obtained simply with a device in which the hydrocarbons are continuously flowed through zones of decreasing intensity. Possible uses and modifications of this device, e.g., for recycling, are discussed. The hydrocarbons may be diluted with inert chemicals (e.g., aromatics), inorganic solids as adsorbents and/or catalysts, and materials giving off secondary radiation (B^{10}, Li^6, etc.). An example of a process using the device is presented in which cetane is converted into a lubricating oil additive. (D.L.C.)

6034 RADIATION POLYMERIZATION OF UNSATURATED NITROGEN COMPOUNDS. Thomas Stanford Tutwiler, William Claude Hollyday, Jr., James Francis Black, and Henry Robinson Ertelt (to Esso Research and Engineering Co.). British Patent 852,831. Nov. 2, 1960.

Copolymers suitable for use as additives for lubricating oils can be prepared by exposing a mixture of an unsaturated nitrogen-containing compound selected from the C_4 to C_{18} alkyl acrylamides, di(C_2 to C_8 alkyl) amino methacrylates, acrylonitrile, and methacrylonitrile with an unsaturated ester to high-intensity radiation of 10^4 to 5×10^6 r/hr at 60 to 80°F for a time sufficient to give a molecular weight of 5,000 to 30,000 Staudinger. The amount of the nitrogen-containing material in the mixture is preferably 0.5 to 5 wt. %. The product copolymer, when blended at ~1% concentration with a lubricating oil of viscosity 45 SUS at 210°F, results in blends of viscosity 50 to 70 SUS at 210°F. The advantages of this method over conventional copolymerization methods are outlined, and 11 examples of this method are given. (D.L.C.)

6035 PRODUCTION OF ISOSTATIC HYDROCARBON POLYMERS AND CATALYST THEREFOR. (to Phillips Petroleum Co.). British Patent 853,781. Nov. 9, 1960.

A catalyst for producing polymers of very high isostatic (head-to-tail linkage) content from monomers may be prepared by mixing at least one irradiated halide or oxyhalide of a Group IVB, VB, or VIB metal with a component selected from Group I, II, or III metals, alloys, hydrides, and organo compounds. The irradiation of the halide or oxyhalide preferably is done in the presence of a hydrocarbon. An example of the catalysts that may be prepared in this way is given in which $TiCl_4$ dissolved in cyclohexane was irradiated, resulting in a brown, mushy material that was used as such and after purification with triisobutylaluminum and cyclohexane to polymerize propylene. The isostatic content of the resulting polymer was 42 and 74% for the unpurified and purified forms of the $TiCl_4$ irradiation product, respectively. (D.L.C.)

6036 IMPROVEMENTS IN OR RELATING TO THE ISOMERIZATION OF PARAFFINIC HYDROCARBONS. (to Esso Research and Engineering Co.). British Patent 854,602. Nov. 23, 1960.

A method for isomerizing straight-chain and branched-chain alkanes to more highly branched hydrocarbons with Friedel-Crafts type catalysts is described in which catalytic activity and selectivity are increased, making it possible to obtain desired isomers in almost quantitative yields. The method comprises exposing a mixture of alkanes with 2 to 200 wt. % catalyst to high-energy ionizing radiation at 40 to 300°F until a dose of 10^{-4} to 10 kwh per lb alkane is reached. Secondary cracking reactions can be repressed by adding to the mixture 2 to 20 wt. % of a cycloparaffin, preferably methyl cyclopentane. An application of this method is described in which the mixture of paraffin, catalyst, and cycloparaffin is fed to a reactor where it is exposed to radiation, the product is passed into a molecular seive which separates the constituents, and the separated unconverted paraffins are recycled to the reactor. Seven examples of this method and the yields obtainable are given using alkanes with 5, 6, and

7 carbon atoms per molecule, particularly n-hexane. (D.L.C.)

6037 IMPROVED LUBRICANTS. (to Esso Research and Engineering Co.). British Patent 854,948. Nov. 23, 1960.

Additives for lubricating oils may be prepared by irradiating solid paraffin wax constituents recovered from lubricating oils, usually with neutrons or γ rays. The irradiation, preferably carried out on a wax fraction containing at least 80 wt. % paraffin hydrocarbons (chiefly straight chain) with 21 to 32 carbon atoms per molecule and a m.p. of 120 to 150°F, results in a hard rubbery material which dissolves in oil, improving its properties such as viscosity index, pour point, and shear stability. Such an additive is preferably used in amounts from 0.1 to 4 wt. % of the oil. Possible variants of this preparation method are described, e.g., using catalysts, and three examples are given. (D.L.C.)

Raw Materials and Feed Materials

6038 (DP-497) REACTION OF URANYL NITRATE HEXAHYDRATE WITH SULFUR. Robert S. Ondrejcin (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1960. 8p. Contract AT(07-2)-1. OTS.

Uranium dioxide was prepared by the reduction of uranyl nitrate hexahydrate with sulfur at 250 to 360°C. The product UO_2 reacted rapidly with HF to form UF_4. The conversion of UO_2 to UF_4 was 99.6% complete. (auth)

6039 (GAT-291) URANIUM HEXAFLUORIDE ISOTOPIC MEASUREMENTS USING AN INTERPOLATIVE METHOD. G. F. Kauffman and N. F. Christopher (Goodyear Atomic Corp., Portsmouth, Ohio). Nov. 30, 1960. 14p. Contract AT(33-2)-1. OTS.

Presented at the Society for Testing Materials, Committee E-14, Meeting on Mass Spectrometry, Atlantic City, N. J., June 27, 1960.

When uranium hexafluoride is admitted to an isotopic mass spectrometer, the resultant ratio of U^{235} to U^{238} is biased because of a phenomenon called memory. All mass spectrometer procedures must in some manner correct for this bias. An interpolative method was developed for the isotopic analysis of production samples, calibration of standard materials, and for the measurement of separation factors where precision and accuracy are of paramount importance. The interpolative procedure reduces the effect of memory to a negligible amount and at the same time compensates for, or eliminates, other sources of error. (auth)

6040 (TID-11272) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Quarterly Progress Report [for] September 1 through November 30, 1960. (Rice Univ., Houston, Tex.). 12p. For [Oak Ridge National Lab.] Subcontract 1491. OTS.

The primary objective of the research is to determine the amount of thorium which might be available as a nuclear fuel on a long-range but economically feasible basis. The following investigations are presented: a summary of past and newly obtained data on the thorium content of igneous rocks; a summary of the precision and accuracy with which thorium is determined in the 1 to 100 parts per million range in rocks; and a current status of the most likely large-tonnage low-grade thorium sources. (W.L.H.)

6041 REACTION OF HYDROGEN WITH URANIUM TRIOXIDE. V. G. Vlasov and V. N. Strekalovskiĭ (Kirov Ural Polytechnic Inst., [USSR]). Doklady Akad. Nauk S.S.S.R. 134, 1384-6(1960) Oct. 21. (In Russian)

The kinetics of uranium trioxide reduction by hydrogen at temperatures from 350 to 500°C and hydrogen pressures of 50 to 400 mm Hg were studied in a vacuum apparatus with continuous control. The reduction, plotted as a function of time at various temperatures and P_{H_2}, proceeds at a constant rate. At constant temperature the activation energy is 20.8 kcal/mol. The final compositions produced at various temperatures show that the reduction never reaches $UO_{2.0}$, and only at 500°C reaches U_4O_9. The reduction begins at 350°C, hence the postulation on preliminary dissociation of UO_3 in the reduction process does not hold. The plotted curves indicate UO_3 reduction to U_3O_8 by a surface reaction between hydrogen, adsorbed on the surface of the oxide, and the oxygen of the oxide. Other curves show the rate of reduction $UO_{2.64x}$. The total reduction rate is proportional to hydrogen pressure. (R.V.J.)

6042 ON THE RECENT DEVELOPMENT OF URANIUM ORE PROCESSING AND METAL PRODUCTION IN ATOMIC FUEL CORPORATION. Yoshiki Imai (Atomic Fuel Corp., [Tokyo]). J. Atomic Energy Soc. Japan 2, 685-97(1960) Nov. (In Japanese)

The results in the ore processing and metal production tests carried out over one year at pilot plants of Tokai Refinery, Atomic Fuel Corporation, Tokaimura, Ibaraki Pref. are given, and the prospect to commercial plants, of 100 tons ore/day and 100 tons U/year each, is presented in terms of material balance diagrams with few reasonable assumptions based on test results. On the ore processing, a prospect on domestic ore reserve and its grade as well is disclosed, the adaptability of domestic ore to milling is analyzed, and then ore characteristics in processing are given summarizing from the test results on acid leaching, solid-liquid separation, and solvent extraction-stripping. The mill cost is studied from the view point of economical feasibility to enterprise, illustrating the relation between allowable cost of ore as well as product price on one hand and mining cost on the other. On the metal production, the superiority of the new refining process, "Excer" process, to the conventional one is demonstrated based on test results and the mechanism and operation of equipment such as Higgins column for ion exchange, ionic cell for electrolysis, etc., are reported in detail. Reduction step from wet-processed UF_4 to metal is reported so as to introduce for the first time the practice into plant scale operation. Low tap density inherent to wet-processed UF_4 showed no unfavorable effect on the reduction at all. Studies on briquette reduction, amine extraction, and scrap recovery are also described. (auth)

Separation Processes

6043 (ANL-6211) NITRIDATION OF CRUCIBLE SKULLS FROM MELT REFINING. T. R. Johnson, G. F. Brunzie, and R. K. Steunenberg (Argonne National Lab., Ill.). Sept. 1960. 23p. Contract W-31-109-eng-38. OTS.

A description is given of the EBR-2 fuel cycle. The effects of nitrogen on the crucible skulls from melt refining are described at length. (W.L.H.)

6044 (CF-57-3-156) AN EXPERIMENTAL STUDY OF THE PERFORMANCE CHARACTERISTICS OF A CONTINUOUS COUNTERCURRENT ION EXCHANGE COLUMN. G. M. Drake, Jr. and F. N. Peebles (Tennessee. Univ., Knoxville). Mar. 1957. 90p. For [Oak Ridge National

Lab.]. Contract W-7405-eng-26, Subcontract S-783. OTS.

A continuous countercurrent ion-exchange column was designed, constructed, and tested for preliminary performance using an ion-exchange system comprising Dowet-Sow, calcium, and sodium. The ion-exchange column contained both loading (adsorption) and stripping (regeneration) sections, the two sections being separated by isolation zones of zero dynamic pressure differential. The resin was moved through the column in a dense bed countercurrent to liquid contamination, and regeneration streams and performance tests were carried out to show the feasibility of this type of column. It is concluded that operation of such columns is feasible, and that further work is needed to effect utilization of hydraulic ram principles to maintain dense bed operations above the fluidization velocity of the resin particles. (auth)

6045 (CF-58-12-43) A PRELIMINARY INVESTIGATION OF A CHROMATOGRAPHIC COLUMN SEPARATION OF RARE EARTHS USING DI(2-ETHYLHEXYL)PHOSPHORIC ACID. John W. Winchester (Oak Ridge National Lab., Tenn.). Dec. 30, 1958. 10p. OTS.

A new chromatographic separation of small amounts of rare earths was devised and tested with carrier-free radiotracers of Nd^{147}, Pm^{147}, and Eu^{155}. The method uses di(2-ethylhexyl)orthophosphoric acid (HDEHP) as a stationary phase supported on a column of aluminum oxide, and elution is with dilute aqueous hydrochloric acid. Column behavior is similar to solvent extraction using HDEHP where separation factors average 2.5 for adjacent rare earths. (auth)

6046 (HW-27401) THE QUANTITATIVE RECOVERY OF PLUTONIUM FROM LABORATORY RESIDUES. W. S. Ferguson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 18, 1953. Decl. Aug. 29, 1960. 82p. Contract W-31-109-Eng-52. OTS.

A method for making quantitative recoveries of plutonium from analytical residues by using precipitation and metathesis reactions is presented. Precipitation of plutonium(IV) hydroxide, plutonium(IV) iodate, plutonium 8-hydroxyquinolate, partial destruction of organic matter with nitric acid, and metathesis of chloride solutions to nitrate solutions are used singly and in combination for the recovery procedures. (W.L.H.)

6047 (HW-60015) HASTELLOY F DISSOLVER INSTALLATION IN 321 BUILDING. C. R. Cooley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 25, 1959. 8p. Contract AT(45-1)-1350. OTS.

Fabrication and installation of a Hastelloy F dissolver for use in processing nuclear fuels is described. The selected design is a vertical tube dissolver that is capable of handling 150 lb maximum of uranium contained in fuel assemblies. Construction materials are described along with heat treatments and installation. Costs are discussed and summarized. (J.R.D.)

6048 (HW-65925) DEPASSIVATION OF 304-L STAINLESS STEEL IN SULFEX DECLADDING SOLUTIONS. E. M. Duke (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 30, 1960. 12p. Contract AT(45-1)-1350. OTS.

In the Sulfex process, stainless-steel cladding, generally 304-L, is removed from fuel elements by dissolution in boiling four to six molar sulfuric acid. It is desirable that the Sulfex decladding procedure be such that the stainless steel is not made passive to the decladding solution or that activation can be assured for cladding already passive. Chemical and electrochemical means of activating passive stainless-steel surfaces in boiling dilute sulfuric acid were studied. Chemical methods included reducing agents and penetrating ions; electrochemical methods included galvanic and electrolytic coupling. Since nitrate may be present in Sulfex solution due to entrapment of some previous nitric acid dissolver solution, the effect of nitrate on depassivation was investigated. Destruction of nitrates in Sulfex decladding solution was also studied. (W.L.H.)

6049 (ORNL-2937) SURVEY OF POTENTIAL VAPOR-PHASE EXPLOSIONS IN DAREX AND SULFEX PROCESSES. K. S. Warren (Oak Ridge National Lab., Tenn.). Jan. 11, 1961. 22p. Contract W-7405-eng-26. OTS.

A survey of the thermodynamics and limits of flammability of gases expected when sodium-bonded stainless-steel-clad reactor fuels are dissolved in dilute aqua regia or sulfuric acid showed that vapor-phase explosions are a definite possibility with the aqua regia system. Reactions of hydrogen with nitrogen oxides, NOCl, and Cl_2 are highly exothermic, and mixtures of the gases are explosive over wide concentration ranges. The Sulfex process, in which only hydrogen is evolved, apparently could be used without additional hazard if the sodium–water reaction could be contained. (auth)

6050 (ORNL-3000) REMOVAL OF SILICA FROM DAREX DISSOLVER SOLUTIONS. A. F. Messing and O. C. Dean (Oak Ridge National Lab., Tenn.). Jan. 11, 1961. 12p. Contract W-7405-eng-26. OTS.

The nature and behavior of silica in Darex dissolver solutions were found to be dependent on solution temperature, the length of time the solution was maintained at temperature, and the concentration of fluoride in the solution. A fluoride-gelatin treatment essentially completely precipitated silica from the dissolver solution, but the precipitate packed on the filter surface and greatly decreased the solution filtration rate. (auth)

6051 (ORNL-3030) FURTHER EVALUATION OF AMINES AS EXTRACTANTS FOR URANIUM FROM SULFATE LIQUORS. W. D. Arnold and D. J. Crouse (Oak Ridge National Lab., Tenn.). Jan. 12, 1961. 43p. Contract W-7405-eng-26. OTS.

Approximately 60 organonitrogen compounds were tested for their ability to extract uranium from acidic sulfate solution. Those showing significant extraction power were tested with respect to other pertinent extraction characteristics, including solubility loss to aqueous liquors, selectivity for uranium, and compatibility with molybdenum liquors. As in previous studies, the simple amines were most useful, a number of the primary, secondary, and tertiary amines showing promise as practicable process extractants. (auth)

6052 (TID-6839) PROGRESS REPORT FOR PERIOD COVERING AUGUST 16–SEPTEMBER 15, 1960. (Ionics, Inc., Cambridge, Mass.). 14p. Contract AT(30-1)-2476. OTS.

In the separation of thorium by means of amine extraction, the behavior of a number of interfering ions was investigated. The radium procedure was improved in order to allow for the determination of Ra^{224}, as well as for Ra^{228} and Ra^{223}. Work is also underway to provide for the determination of the β emitter Ra^{228}. (W.L.H.)

6053 (TID-11414) BEHAVIOR OF ACTINIDES AND TRANSURANICS IN SOLVENT EXTRACTION. Progress Report for June 1, 1957 through January 31, 1958. K. K. Innes and R. P. Wischow (Vanderbilt Univ., Nashville). Feb. 1, 1958. 16p. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 914. OTS.

The extraction-rate equipment is described, and data is presented for the solvent-extraction-rate study of nitric acid from an aqueous media into an organic phase of tri-butyl phosphate diluted with a hydrocarbon diluent. Photomicrographic measurements indicate that a droplet diameter of about 10 μ yields an interfacial (area/volume) ratio of 6×10^3 cm^2/cm^3 for the dispersed organic phase. A preliminary value for the nitric acid extraction energy of activation is 2825 cal/mol. The nitric acid extraction reaction over the interval investigated obeys first-order kinetics. Rate constants are reported for the 10 and 20% tri-butyl phosphate organic phase in contact with a 1.00M nitric acid aqueous phase. (auth)

6054 (UCRL-9415) NONEQUILIBRIUM THERMODYNAMIC THEORY FOR CONCENTRATION PROFILES IN LIQUID EXTRACTION. Alphonse Hennico and Theodore Vermeulen (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 30, 1960. 56p. Contract W-7405-eng-48. OTS.

The pattern or profile of concentration change in each of the two countercurrent streams within a packed extraction column involving a three-component system is generally assumed to follow either branch of the mutual-solubility curve for the system. In the work reported, such concentration profiles were computed for an idealized extraction process, and the profiles were found to depart from the equilibrium curve. The idealized extraction has the following characteristics: it involves a system with thermodynamically defined equilibrium behavior, rather than with known experimental behavior. Mass-transfer-coefficient ratios are held constant at any one steady-state condition of operation (called a "run") but are varied in different runs. A modified activity-gradient, derived both for molecular diffusion and for penetration-theory conditions, is postulated to govern mass-transfer and is used in place of the usual concentration driving potential. The present calculations show that the concentration profile for the raffinate will usually be carried into a metastable condition, represented by a locus inside the equilibrium curve. The extract compositions always remain appreciably outside the equilibrium curve. Solute depletion, mainly, is found to explain the result for the raffinate phase in much the same way that temperature lowering leads to supersaturation in binary solutions. Solute enrichment is the cause of the extract-phase behavior. The distance between the calculated concentration paths and the equilibrium curve depends on the values of the mass-transfer coefficients. Values of the number of transfer units obtained from the exact concentration profiles can differ as much as 10% from the values given by the usual equilibrium-curve approximation. (auth)

6055 (CEA-tr-R-1002) SÉPARATION DES ÉLÉMENTS PAR EXTRACTION À L'AIDE DE SUBSTANCES ORGANIQUES FACILEMENT FUSIBLES. (Separation of Elements by Extraction with Easily Melting Organic Materials). V. I. Kuznetsov and I. V. Seriakova. Translated into French from Zavodskaya Lab. 23, 1176-86(1957). 17p.

A study was made of the extraction of elements by low-melting organic solvents and mixtures of organic solids and liquids by the oxonium ammonium mechanism. The solvent is melted and then plunged into boiling water then cooled. The organic phase solidifies allowing easy separation from the aqueous. As an example, Cu is separated from Co by α-naphthylamine and Fe from Al by amyl acetate and paraffin. (T.R.H.)

6056 (CEA-tr-X-231) SÉPARATION DE L'ACIDE NITRIQUE ACCOMPAGNANT L'EXTRACTION DU NITRATE D'URANYLE AU PHOSPHATE DE TRIBUTYLE (TBP). (Separation of the Nitric Acid from Extraction of Uranyl Nitrate by Tributyl Phosphate (TBP)). T. Sato and F. Goto. Translated into French from Kôgyô Kagaku Zasshi 62, 684-6(1959). 20p.

An experimental study was made of the passage of HNO_3 into the solvent phase in TBP extraction of $UO_2(NO_3)_2$. Aqueous HNO_3 solutions of different normalities and containing a given quantity of $UO_2(NO_3)_2$ were extracted with TBP diluted by kerosene. The variation of the equilibrium distribution coefficient for HNO_3 and $UO_2(NO_3)_2$ as a function of TBP concentration was obtained. To study the relation between the quantity of HNO_3 and $UO_2(NO_3)_2$ in the solution, the solution with varying concentrations was extracted with TBP of constant concentration. It was found that the amount of HNO_3 passing into the solvent phase varies enormously with HNO_3 and TBP concentration. (T.R.H.)

6057 (CEA-tr-X-232) SÉPARATION DU TELLURE ET DE L'IODE PAR RÉSINE ÉCHANGEUSE D'IONS. (Separation of Tellurium and Iodine by Ion Exchange Resin). M[ariko] Inarida (Inada). Translated into French from Nippon Kagaku Zasshi 80, 399-400(1959). 15p.

Because of the complexity of the distillation method, the ion exchange method was studied for the separation of tellurium and iodine. A 4N HCl solution of tellurium and iodine was passed through a column of Amberlite IRA-400 resin (type, RCl; grain size, 0.124 to 0.175 mm; and column size, 1 cm by 5 cm high). A wash with 4N HCl caused the Te^{6+} to appear stoichiometrically in the eluant and the passed liquor. The Te^{4+} was washed down by 0.1 to 1N HCl. Finally, washing with 10N HCl caused stoichiometric separation of the iodine. (T.R.H.)

6058 TRIBUTYL PHOSPHATE SOLVENT EXTRACTION COLUMN DESIGN. Donald R. Olander (Univ. of California, Berkeley). Ind. Eng. Chem. 53, 1-5(1961) Jan.

The design procedure for the solvent extraction separation of heavy metal nitrates by tributyl phosphate-diluent mixtures was programed for an IBM 704 computer. The code computes the number of theoretical stages required in the scrubbing and extracting sections of a center-fed unit for an aqueous feed consisting of up to four macro heavy metal nitrates and HNO_3. The usual criterion for minimum flow rates, simultaneous attainment of equilibrium at the feed stage in both sections, was inapplicable. However, no analytical method was devised for determining true limiting flow rates. Distribution coefficients at each state were assumed to be governed by an ideal complexing reaction between inorganic nitrates and tributyl phosphate. (auth)

6059 RADIATION DAMAGE TO TBP/KEROSENE SOLVENT. EFFECT ON BEHAVIORS OF FISSION PRODUCTS AND NITRIC ACID. Takehiko Ishihara, Takeshi Tsujino, and Yutaka Yamamoto (Japan Atomic Energy Research Inst., Tokyo). J. Atomic Energy Soc. Japan 2, 659-70(1960) Nov. (In Japanese)

Radiation damage to 30 vol. % TBP(tributyl phosphate)/

kerosene solvent was investigated to study the behavior changes of fission products and nitric acid in extraction and in stripping with 0.01 N nitric acid at 25°C. In these extraction-stripping experiments, three types of solvent were used; namely, Co^{60} γ-ray irradiated (10^4 to 10^8r) solvent, non-irradiated solvent, and synthetic "damaged solvent," or DBP (dibutyl phosphate)-MBP (monobutyl phosphate), butanol, or pyrophosphoric acid added to TBP/Kerosene. It was found that $Zr^{95}-Nb^{95}$ is extremely affected in extraction-stripping with radiation damaged and synthetic damaged solvent compared with $Ru^{106}-Rh^{106}$, I^{131}, $Ce^{144}-Pr^{144}$, and gross fission products, and that its behavior change depends mainly on the formation of DBP-MBP, but not on that of butanol or pyrophosphate. $Ru^{106}-Rh^{106}$ is hardly affected in extraction with damaged solvent and is affected only in stripping from damaged solvent. Neither $Ce^{144}-Pr^{144}$ nor nitric acid is influenced by radiation damage to the solvent. I^{131} behavior change is different from others. Emulsion formation was observed only in $Zr^{95}-Nb^{95}$ extraction with 10^7r or more irradiated and DBP-MBP added solvent (0.01 g or more /l-solvent). Settling time or phase separation time changes may not affect the process significantly except in the case of emulsion formation. (auth)

6060 AN INFRA-RED STUDY OF THE SYSTEMS TRI-n-BUTYL PHOSPHATE–HNO_3 AND BIS-(2-ETHYLHEXYL)-PHOSPHORIC ACID–HNO_3. D. F. Peppard and J. R. Ferraro (Argonne National Lab., Ill.). J. Inorg. & Nuclear Chem. 15, 365-70(1960) Oct. (In English)

An infrared study of the systems tri-n-butyl phosphate–HNO_3 and bis-(2-ethylhexyl)-phosphoric acid–HNO_3 was made. It was observed that the nitric acid extracting into these organophosphorus solvents is predominantly of a molecular nature, and that the bonding is primarily to the phosphoryl oxygen. In the TBP system, at low HNO_3 concentrations and high aqueous content, some contribution from ionized HNO_3 species is possible. The distribution coefficients of HNO_3 for these systems are reported. (auth)

6061 EFFECTS OF STRUCTURE OF N,N-DISUBSTITUTED AMIDES ON THEIR EXTRACTION OF ACTINIDE AND ZIRCONIUM NITRATES AND OF NITRIC ACID. T. H. Siddall, III (E. I. du Pont de Nemours & Co., Aiken, S. C.). J. Phys. Chem. 64, 1863-6(1960) Dec.

The effects of changes in the structure of 21 N,N-disubstituted amides on the extraction of actinide and zirconium nitrates, and of nitric acid are given. Successive alkyl substitution on the α-carbon atom greatly decreases the extraction of quadrivalent actinides and of zirconium, but only moderately decreases the extraction of hexavalent actinides and nitric acid. The extraction mechanisms for the extraction of uranyl nitrate and nitric acid are very similar to the mechanisms of extraction by trialkyl phosphates and dialkyl alkylphosphonates. However, the extraction mechanisms for the quadrivalent species by amides appear to be quite different from the mechanisms with the phosphorus compounds. A connection between the stretching frequency of the carbonyl bond in the amides and their power as extractants is substantiated in a general and qualitative way, but an exception is noted. (auth)

6062 CHLORINATION OF TRAVANCORE MONAZITE FOR THE RECOVERY OF THORIUM AS THORIUM TETRACHLORIDE. Y. W. Gokhale, R. Manocha, and D. Sen (Atomic Energy Establishment, Trombay, India). J. Sci. Ind. Research (India) B 19, 422-5(1960) Nov. (In English)

A process for the recovery of thorium as anhydrous thorium tetrachloride from monazite sand was described. Thorium chloride was obtained by chlorinating monazite and subsequently distilling thorium chloride from the reacted mass by taking advantage of the differences in the volatility of the various chlorides. The product obtained contained 0.18% rare earths. (auth)

6063 LABORATORY INVESTIGATIONS ON THE LEACHING OF THE URANIUM CONTENT OF COAL ASHES OF AJKA, FROM THE VIEWPOINT OF UTILITY. Zoltán Sámsoni. Magyar Tudományos Akad. Atommag Kutato Intézete (Debrecen), Közlemenyek 2, 155-75(1960). (In Hungarian)

Investigations were carried out of leaching uranium by sodium carbonate and sulfuric acid from the ashes of coal samples derived from two different sites of the Ajka coal fields and preenriched in carbon and uranium partly by selection from wagonloads and partly by separation in smaller quantities according to specific weight. It was found that although the method of leaching by sodium carbonate was not applicable in the case of coal ashes from Ajka, an uranium recovery of over 90% became possible by sulfuric acid. Furthermore, the optimal relations for the method of using sulfuric acid were studied; and it was found that in the case of an appropriate preenrichment, the leaching of uranium by unit of weight requires a consumption of sulfuric acid approximately three times greater in order of magnitude. Tests of an informative character were made also for direct uranium leaching from coal; and a recovery of over 90% was possible from preenriched coal, with the coal fraction below a specific weight of 142, by means of the sodium carbonate method as against a recovery of about 70% with sulfuric acid and about 50% with hydrochloric acid. (auth)

6064 SOLVENT EXTRACTION RECOVERY OF TECHNETIUM, NEPTUNIUM, AND URANIUM FROM FLUORINATION PLANT RESIDUES. C. F. Coleman, F. A. Kappelmann, and B. Weaver (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 8, 507-14(1960) Dec.

Extraction with a tertiary amine in hydrocarbon solution is recommended for recovery of the technetium and neptunium that can accumulate in uranium fluorination plant residues, together with recovery of the uranium for recycle. A single-cycle process provides coextraction of these three elements and separation by consecutive stripping, giving good recoveries and relatively high mutual separation. The chemical flowsheet was tested through the stage of continuous countercurrent demonstration in laboratory scale equipment using a commercial tertiary amine to process actual plant feed solution. (auth)

6065 INVESTIGATION OF URANIUM EXTRACTION FROM URANIUM ORE SOLUTIONS. Juliusz Dobrowolski (Centre d'Études Nucléaires de Fontenay-aux-Roses, France). Nukleonika 5, 583-4(1960). (In Polish)

Various amine solutions can be used in the extraction of uranium from an acid solution of uranium ores, some of which are less effective than others. Further, the extraction capability of solutions of regenerated amine may be less than that of freshly prepared amine solutions. Experiments with vanadium and iron compounds added to an acid-uranium solution indicated that reduction of the metals occurred when N-dodecylamine (9D-178, prepared by Rohm and Haas) was used. The accompanying partial oxidation of the amine solution is responsible for the decrease in its effectiveness when it is repeatedly regener-

sted and reused to extract uranium. However, preliminary tests carried out with a different type amine solution indicated no apparent decrease in the effectiveness of the solution. (TTT)

6066 URANIUM SCRAP PROCESSING ACTIVITIES OF THE W. R. GRACE CO., DAVISON CHEMICAL DIVISION. E. R. Johnson (Davison Chemical Co., Erwin, Tenn.). p.29-32 of "Institute of Nuclear Materials Management First Annual Meeting, Columbus, Ohio, June 20-21, 1960." Pittsburgh, Institute of Nuclear Materials Management, 1960.

The status of uranium scrap processing projects of the W. R. Grace Co. is reviewed. The projects include the treatment of scrap materials from fuel-element production and fabrication for nonirradiated uranium recovery, the separation of U^{233} from U^{232} daughter products, and a study of the technical and economic feasibility of building and operating a private facility for spent fuel-element reprocessing. The treatment for uranium recovery consists of dissolution, solvent extraction to yield a pure $UO_2(NO_3)_2$ solution, and treatment of the solution to give the final product. The separation of U^{233} from U^{232} daughters also entails solvent extraction. In the study of reprocessing plant feasibility, it is concluded that sufficient technical data are available for construction and operation of such a plant. (D.L.C.)

6067 INTEGRATED POWER FUEL REPROCESSING. Fred H. Tingey (Phillips Petroleum Co., Idaho Falls, Idaho). p.33-48 of "Institute of Nuclear Materials Management First Annual Meeting, Columbus, Ohio, June 20-21, 1960." Pittsburgh, Institute of Nuclear Materials Management, 1960.

A mathematical assessment of the savings obtained in service charges for spent reactor fuel processing by pooling reactor cores is given for MTR-ETR type elements, and tables of apparent savings are presented. It is concluded that if a participant's fuel quantity to be processed is less than 1 day's output of the processing plant or more than 8 days' output, it is definitely to his advantage to pool; in the range 1 to 8 days' output, the decision to pool must be made on the basis of other factors. (D.L.C.)

6068 BISMUTH HYDROXIDE METHOD FOR RECOVERING PLUTONIUM. (to United Kingdom Atomic Energy Authority). British Patent 853,311. Nov. 2, 1960.

A method for recovering plutonium from irradiated uranium is outlined in which bismuth hydroxide carrier precipitation is used following the usual bismuth phosphate precipitation method. The advantages of this method are that bismuth ions are already present in the solution, that bismuth hydroxide will carry down plutonium in either the reduced or oxidized state, rendering the reduction step optional, and that volume reduction factors greater than 300 are possible. The steps involved in this method are illustrated in four examples which give recoveries >90%; interfering iron may be removed by precipitation with sodium or potassium ferrocyanide. A flowsheet of the process is included. (D.L.C.)

6069 IMPROVEMENTS IN OR RELATING TO THE RECOVERY OF URANIUM. Thomas Garfield Thomas and Stanley George Wilson (to United Kingdom Atomic Energy Authority). British Patent 853,343. Nov. 2, 1960.

Magnesium fluoride and calcium fluoride slags resulting from uranium production from UF_4 may be leached for uranium recovery in stainless steel vessels with nitric acid solutions of such concentrations that the final acidity is 0.5 to 5N; if the temperature is restricted to 40 to 80°C, the corrosion rate of the vessel is low and acceptable. The resulting aqueous solution may be treated with TBP in the usual manner to remove uranium. Separan 2610 may be used as a conditioning or flocculating agent to settle the fine particles before filtering the leach slurry. One example of this method is given. (D.L.C.)

6070 PROCESS FOR THE PRODUCTION OF ELEMENTS 93 (NEPTUNIUM) AND 94 (PLUTONIUM). Egon Bretscher, Norman Feather, Hans Heinrich Von Halban, and Lew Kowarski (to United Kingdom Atomic Energy Authority). British Patent 854,818. Nov. 23, 1960.

Neptunium and plutonium may be produced in uranium and separated therefrom by irradiating a solution of uranyl nitrate in methyl ethyl ketone or uranyl nitrate itself and then dissolving in methyl ethyl ketone, and treating the solution to separate the two elements. The treatment may be carried out in two ways: (1) by adsorption with dehydrated powdered charcoal and extraction from the charcoal with hot 10% H_2SO_4 and (2) by displacement of the water by addition of xylene, the water containing most of the neptunium and plutonium salts. Examples are given. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

6071 (IDO-14527) ELECTROSTATIC PRECIPITATION OF SUBMICRON ALUMINA PARTICLES. E. Hylsky (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 6, 1960. 14p. Contract AT(10-1)-205.

The use of an electrostatic precipitator to remove alumina particles less than 1.2 μ in diameter from a simulated fluidized bed waste calciner off-gas stream is described. Efficiencies of 98.7 to 99.5% were obtained in a water-film single-stage precipitator. Incoming particle loading ranged from 0.9 to 14×10^{-5} grains of alumina solids per cubic foot of gas. At 20 to 25 kilovolts, exit gas loading was 0.5 to 10×10^{-5} grains per cubic foot. The effect of operating variables is discussed. (auth)

6072 (NP-9707) THE SYNTHESIS AND EVALUATION OF NEW BASE STOCK FLUIDS FOR GAS TURBINE APPLICATION. Quarterly Progress Report No. 4 Covering Period September 1, 1960 to November 30, 1960. (Wyandotte Chemicals Corp., Wyandotte, Mich.). Dec. 1, 1960. 71p. Contract AF33(616)-6749.

Progress is reported on the synthesis and evaluation of new pyrazine derivatives for lubricant applications. Emphasis was placed on the preparation of new 2-substituted-3-methylpyrazines, 2-substituted-3,6-dimethylpyrazines and conversion of these intermediates to further modified fluid derivatives. Some physical properties of these materials are discussed. In particular, efforts in this quarter were concentrated in the area of phenoxypyrazines. Representatives from 2-phenoxy-3-substitutedpyrazine and 2-phenoxy-6-substituted-3-methylpyrazine classes of compounds were prepared by phenylation, alkylation, and aralkylation reactions of the intermediate 2-phenoxy-3-methylpyrazines and 2-phenoxy-3,6-dimethylpyrazines. Two liquid representatives from the 2-anilino-3-substitutedpyrazine class were also prepared. The thermal and oxidative screening of the pyrazine derivatives was continued. One compound displayed noteworthy stability, viz., 2-phenoxy-3-(5-nonyl)pyrazine. In general,

the 2-phenoxy-3-alkylpyrazines demonstrated better thermal stability than the 2-phenoxy-3-benzylpyrazines. (For preceding period see NP-8876.) (auth)

6073 (ORNL-3008) SLURRY FEED-PUMP DEVELOPMENT. E. C. Hise (Oak Ridge National Lab., Tenn.). Nov. 10, 1960. 23p. Contract W-7405-eng-26. OTS.

A nuclear reactor utilizing a suspension of thorium or uranium oxide in water as the fertile or fissile material requires pumps capable of injecting several gallons per minute of a slurry that is 50% or more solids by weight into a high-pressure system at up to 2000 psi. The adaptation of a hydraulically driven metal-diaphragm pump for this slurry service is described. The testing and performance of such pumps are described. (auth)

6074 (PWAC-297) PUMP TESTS CONDUCTED FOR THE DEVELOPMENT OF THE PRATT AND WHITNEY AIRCRAFT LIQUID METAL TURBOPUMP, TP-1. H. V. Marman, R. S. Lombard, P. G. Standley, C. W. Grennan, and C. E. Fuchs (Pratt and Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.). Dec. 15, 1960. 164p. Contract AF33(600)-41233.

Initial development tests of the electric drive versions of the TP-1 turbopump were conducted in both water and liquid metal in the Pump Turbine Laboratory at CANEL. The hydraulic characteristics of this 3000 gpm NaK turbopump were established at approximately half design speed during 276 hr of water tests. In addition, calibration of the gas sweep and lubrication circuits was accomplished. It was established that the over-all pump efficiency was 74% at a flow rate of 1500 gpm for a speed of 4000 rpm. A total of 60.1 hr was accumulated in hot NaK which included 26.8 hr at a temperature of 1050°F. The pump speed during these latter tests was restricted to 3000 rpm because of vibration problems caused by the test facility jack-shaft. These first liquid metal development tests were prematurely stopped because of test-facility problems and pump-assembly errors. However, these tests served to indicate that no major design deficiencies exist in the temperature range investigated. To support the above TP-1 turbopump development effort, a series of tests was conducted on an available 400 gpm NaK pump, designated Model S-1, which was modified to incorporate the essential design features of the sealing scheme of the TP-1 unit. A total of 1541 hr of hot NaK testing and 195 hr of water testing was completed on this model pump. The liquid metal tests included a successful endurance test of 1148 hr at 1000°F. Limited water testing of two other available model pumps with capacities of 1600 gpm and 2000 gpm were accomplished to obtain basic hydraulic information on cavitation, head-flow, efficiency and radial thrust characteristics. The data taken on the 1600 gpm Model P-6 pump indicated a severe mismatch between the diffuser vanes and the impeller with resulting inferior performance. The tests of the 2000 gpm Model P-9 pump were more satisfactory, and a peak pump hydraulic efficiency of 73% was obtained at a flow rate of 1350 gpm and a shaft speed of 3500 rpm. (auth)

6075 (SC-4441(RR)) HIGH EXPLOSIVE DITCHING FROM LINEAR CHARGES. Interim Report. R. H. Carlson (Sandia Corp, Albuquerque, N. Mex.). May 1960. 55p. Project TOBOGGAN. OTS.

Linear explosives weights varied from 0.23 to 42.7 lb/ft in linear and single high-explosive charges fired at Yucca Lake playa, Nevada Test site, during the fall of 1959. Dimensions and volumes of resulting apparent ditches and craters are presented as a function of charge burst depth. Scaling relation determined is as expected, i.e., square-root scaling of linear-charge weight per foot for ditch width and depth and a direct linear-charge weight relation to ditch volume. (auth)

6076 (SCTM-150-60(12)) ANALYSIS AND PROPOSALS FOR THE DESIGN OF THE DOWNSTREAM SUSPENSION AND TRANSLATION SYSTEM OF THE SANDIA CORPORATION 18-INCH WIND-TUNNEL FACILITY. J. W. O'Neill (Sandia Corp., Albuquerque, N. Mex.). June 28, 1960. 49p. OTS.

Various systems for supporting and translating the diffuser and pitching strut cell assembly of the 28-in. hypersonic wind tunnel are presented and analyzed. Proposals within the scope of tunnel load and distribution figures now available are made on the basis of this analysis. (auth)

6077 (SCTM-315-60(71)) WIND TUNNEL STUDY OF THE INFLUENCE OF ORIFICE GEOMETRY AND FLOW RATES ON THE MEASURED PRESSURE ERROR OF A STATIC PRESSURE PROBE AT MACH 3. Glen W. Zumwalt (Sandia Corp., Albuquerque, N. Mex.). Nov. 1960. 19p. Project No. 13-409.10. OTS.

Tests were conducted in the Jet Propulsion Laboratory's 20-in. Supersonic Wind Tunnel to determine the effect of hole-spacing geometry on the measured pressure error due to "breathing" for a pressure-sensing probe at Mach 3.01. A long, thin, cylindrical probe was used, having one to three rows of holes, both in line and rotated with respect to each other, at various spacings between rows. Measured amounts of air were expelled from the holes, and the fractional change in measured pressure at the holes was expressed as a function of the breathing-flow parameter and the spacing. (auth)

6078 (TID-11279) THEORY AND DESIGN DATA FOR CONTINUOUS-FILM SELF-ACTING JOURNAL BEARINGS OF FINITE LENGTH. Interim Report. Harold G. Elrod, Jr. and Stanley B. Malanoski (Franklin Inst. Labs. for Research and Development, Philadelphia). Nov. 1960. 54p. Contract Nonr-2343(00). (I-A2049-13). OTS.

The general theory of continuous-film lubrication is presented. The results for gas-lubricated bearings are shown to be capable of generalization to any fluid with a linear-pressure-density relation. In particular, the results are applicable to lightly-loaded bearings employing any single-phase substance. Gas-bearing design formulas for both infinite and finite-length bearings are summarized in the cases of $\Lambda \to 0$, $\epsilon \to 0$, and $\Lambda^{-1} \to 0$. A new analysis for edge-effects in finite gas-bearings operating at high speed is presented. Finally rapid slide-rule methods are illustrated for constructed load coefficient and attitude angle curves. (auth)

6079 (UCRL-5597) DISCUSSION ON OPTIMIZATION OF LARGE OIL-PUMPED ULTRA-HIGH VACUUM SYSTEMS. N. Milleron and L. L. Levenson (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 12, 1960. 19p. Contract W-7405-eng-48. OTS.

Discussion is directed toward eventual optimization of the largest diffusion-pump systems. Less than 100 diffusion pump fluid molecules per cm^2/sec are possible to detect using an accumulation method. Optimization discussed demands highest possible system speed compatible with the above contamination rate. Bakeable oil diffusion pump systems, with equal orifice valve-trap units, without conventional baffling, permit theoretical throughput speeds up to 0.3 of the system orifice. The average

backstreaming rate of oil in two unconventionally baffled commercial pumps of 6- and 10-in. size is reduced to $<3 \times 10^{-4}$ g/cm^2/24 hr, including heating and cooling the pump boiler. A Ho factor of > 0.4 is maintained. Results on trapping with activated alumina, retained by a wire mesh, at both liquid-nitrogen and room temperature are included. A variety of pumping speed measurements and bakeable combination valve-trap units is discussed. (auth)

6080 (UCRL-9129) THERMAL STRESSES IN A LIQUID HYDROGEN TRANSFER LINE. William L. Pope (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 20, 1960. 20p. Contract W-7405-eng-48. OTS.

A variable-length vacuum-insulated liquid hydrogen transfer line is described. The vacuum system is semipermanent, and segments of the line are assembled with only threaded vacuum fittings. Thermal stress calculations are presented for a statically indeterminate union coupling. (auth)

6081 (WADC-TR-59-764) LUBRICATION BEHAVIOR OF LIQUID METALS. Period covered: July 1958 through September 1959. Patrick H. McDonald (North Carolina State Coll., Raleigh). Jan. 15, 1960. 77p. Project No. 7022. Contract AF33(616)-5885. OTS.

The lubricating behavior of liquid metals in two categories, hydrodynamic and boundary lubrication, is described. The basic theory of the hydrodynamic study is that of the Reynolds equation. This theory has been extended, after the manner of Christopherson, to a new state of development. An experimental device has been designed and constructed for confirming this theory as it relates to liquid metals. The complex and elaborate aspects of this apparatus are described in detail in the report. The study of a variety of liquid metals with this apparatus is anticipated. A macroscopic theory of the boundary lubrication region has been employed. This theory has been applied to a cylinder-flat combination, and the lubricating behavior has been seen to depend upon the state of contact stress for this configuration. An apparatus for these investigations is also described in the report. (auth)

6082 (DEG-Inf. Ser.-148) ELECTRICAL EQUIPMENT FOR TEXTILE AND WASHING MACHINE CENTRIFUGES. A. Waclawik. Translated by H. W. Curtis from Elektrotech. u. Maschinenbau 53, 402-4 (1935). 6p.

After summarizing the governing factors of a practical design, a suitable type of construction for the three-phase motor is described. (auth)

6083 IMPROVEMENTS IN HEAT EXCHANGERS ESPECIALLY APPLICABLE TO THE COOLING OF ATOMIC PILES. (to Societe Nationale d'Étude et de Construction de Moteurs d'Aviation). British Patent 846,950. Sept. 7, 1960.

Heat exchangers of the tube bundle type can be designed for improved heat transfer by pulsing the flow at a frequency tuned to the natural frequency of the tubes, the phases of the flow through the tubes being adjusted so that they are out of phase with each other to prevent vibration. The flow pulsing may be accomplished with valves coupled to cams, rotating flaps, rotary disc with ports, reciprocating and centrifugal compressors, etc., and ways of dephasing the flow with these devices are outlined. Dephasing may be performed simply with an aerodynamic nonreturn valve. Drawings are included. (D.L.C.)

6084 IMPROVEMENTS IN OR RELATING TO EQUIPMENT FOR HANDLING DANGEROUS e.g. RADIOACTIVE SUBSTANCES. John Robert Vernon Dolphin (to United Kingdom Atomic Energy Authority). British Patent 848,199. Sept. 14, 1960.

A chamber of circular cross section with a personnel passage leading to it is designed for handling, processing, or treating radioactive and/or toxic substances. The chamber is provided with glove ports in a window and with a rotatable, circular table. (D.L.C.)

6085 IMPROVEMENTS IN OR RELATING TO GAS FILTERS. (to Commissariat à l'Énergie Atomique). British Patent 850,308. Oct. 5, 1960.

A device for holding gas filters for removing radioactive particles, e.g., from the coolant of a gas-cooled reactor, is designed so that the filter is gas-tight and can be removed from the device at a distance. The device comprises two tubular sockets with the filter held in place between them and a sleeve enclosing the assembly. In replacing the filter, the sleeve is slid out of place so that the filter is exposed and can be removed easily with a long rod. (D.L.C.)

6086 IMPROVEMENTS IN OR RELATING TO VACUUM CONTROL VALVES. (to Commissariat à l'Énergie Atomique). British Patent 851,444. Oct. 19, 1960.

A fluid-tight vacuum control valve capable of withstanding high temperatures, e.g., 1000°C, and of being coupled to another identical valve is designed comprising a casing with a slideable unit movable in the casing by an external button to close or open the valve. Provision is made for cooling fluid circulation in the valve. (D.L.C.)

6087 IMPROVEMENTS IN OR RELATING TO ROTARY SHAFT SEALS AND PUMPS PROVIDED WITH SUCH SEALS. Harry E. La Bour. British Patent 854,526. Nov. 23, 1960.

A seal for the vertical rotary shafts of centrifugal pumps is designed so that the pump can be used for long periods, e.g., in the presence of radioactivity, without maintenance other than oiling the motor or shaft. The seal has one side exposed to the atmosphere and the other to the pump intake and means for feeding lubricant to the side toward the atmosphere and for preventing suction of the lubricant to the other side in the case of seal leakage. (D.L.C.)

6088 ELECTRON BEAM WELDING FURNACE. (to Wild-Barfield Electric Furnaces, Ltd.). British Patent 854,581. Nov. 23, 1960.

An electron beam welding furnace for welding reactive and volatile metals under vacuum is designed which comprises a vacuum-tight furnace and cathode chambers with four pumps for maintaining pressures of 0.1μ Hg in the cathode chamber and 1 to 10μ Hg in the welding chamber. With this furnace the melting of the metal at the weld can be controlled easily, and the possibility of gas discharge in the high-voltage portion is eliminated. (D.L.C.)

Heat Transfer and Fluid Flow

6089 (AFOSR-TN-60-1164) EFFECT OF ROUGHNESS ON TRANSITION IN SUPERSONIC FLOW. E. R. Van Driest and C. B. Blumer (North American Aviation, Inc. Missile Div., Downey, Calif.). Mar. 1960. 38p. (MD-60-329).

Experiments carried out in the 12-in. supersonic wind tunnel at the California Institute of Technology to investi-

gate the effect of three-dimensional roughness elements (spheres) on boundary-layer transition on a 10° (apex angle) cone without heat transfer are reported. The local Mach number for these tests was 2.71. The data show that the minimum effective size of trip required to bring transition to its lowest Reynolds number varies as the one-fourth power of the distance from the apex of the cone to the trip. Use of available data at other Mach numbers indicates that the Mach-number influence for effective tripping is taken into account by the simple expression $Re_{\delta^*} = 1050\ [1 + (\gamma-1)/(2)\ M_\delta^2](k/\delta^*)^{-2}$. (auth)

6090 (CF-55-6-49(Pt.I)) BOILING RUBIDIUM AS A REACTOR COOLANT. PREPARATION OF RUBIDIUM METAL, PHYSICAL AND THERMODYNAMIC PROPERTIES, AND COMPATIBILITY WITH INCONEL. Merrill J. Whitman and Don L. Stockton (Oak Ridge School of Reactor Technology, Tenn.). Aug. 1954. Decl. July 1, 1960. 144p.

Rubidium metal was investigated as a possible heat-transfer medium for an aircraft reactor. The separation of rubidium from other alkali metals by ion exchange was demonstrated. Data are presented on the physical and thermodynamic properties of rubidium and corrosive effects on Inconel at elevated temperatures. It was concluded on the basis of empirical formulas that more heat can be transferred in a boiling rubidium system than in a comparable boiling water system. (C.H.)

6091 (DEG-Report-214) PRELIMINARY REPORT ON AN EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER IN A FLUID CONTAINING A DISTRIBUTED HEAT SOURCE. S. A. Fisher and D. Wilkie (United Kingdom Atomic Energy Authority. Development and Engineering Group, Windscale, Cumb., England). June 23, 1960. 30p. BIS.

An investigation is being carried out to give experimental information for the appraisal of existing theories on the convective heat transfer and flow in enclosed regions containing a distributed heat source. The results of some preliminary experiments with a cylindrical cell are given, and the apparatus and results for a two-dimensional cell are described. A Mach-Zehnder interferometer was used to measure temperatures. These experiments indicate that Woodrow's theory is useful for predicting approximate temperature differences at low heat generation rates but that velocities are much lower than predicted. (auth)

6092 (MIT-NSL-TR-396) A PRELIMINARY EXPERIMENTAL STUDY OF SKIN FRICTION IN MAGNETO-GASDYNAMICS. Thomas McClimans (Massachusetts Inst. of Tech., Cambridge. Naval Supersonic Lab.). Oct. 1959. 85p. (NP-8905).

The theory of hydromagnetics and its application to skin friction forces are presented. With a continuous-flow plasma jet, experiments were conducted for the flow of high-temperature air in a circular tube. The friction forces were determined by pressure drops along the tube. Fluid temperatures in the experiments ranged from 6000 to 8000°R, which gave low Hartmann numbers. Feasibility of further experiments in the ionized gas region is discussed. (auth)

6093 (MT-41) EXPERIMENTAL EXAMINATION OF LOCAL PROCESSES IN PACKED BEDS OF HOMOGENEOUS SPHERES. PART I: THE LOCAL PACKING IN RANDOMLY STACKED SPHERE BEDS. PART II: THE LOCAL HEAT TRANSFER OVER THE SURFACE AREA OF A SPHERE IMMERSED IN A PACKED BED OF INFINITE DIMENSIONS AND ARRANGED IN RHOMBOHEDRAL ARRAY. J. Wadsworth (National Research Council of Canada. Div. of Mechanical Engineering Ottawa). Feb. 1960. 77p. (NRC-5895).

The local packing, occurring in cylindrical containers when randomly stacked with homogeneous spheres, is examined over a range of 4 to 24 of the ratio of container diameter to sphere diameter. Sphere packings are examined both as a function of radial and vertical position in the bed. It is concluded that only one kind of close packing exists or tends to exist in random packing, i.e., rhombohedral. Some understanding of the packing mechanism has evolved for the largest cylindrical container, i.e., container to sphere diameter ratio of 24. A three-dimensional picture is presented of the heat transfer over the surface area of a sphere when immersed in a packed bed of "infinite" dimensions arranged in rhombohedral No. 6 blocked passage array for a range of Reynolds numbers of 8,000 to 60,000, where Reynolds number is based on sphere diameter, average velocity of the coolant across the cross-section of the bed in the absence of the spheres, and fluid properties evaluated at the mean film conditions. (auth)

6094 (NASA-TN-D-578) EFFECT OF SHIELD POSITION AND ABSORPTIVITY ON TEMPERATURE DISTRIBUTION OF A BODY SHIELDED FROM SOLAR RADIATION IN SPACE. Lester D. Nichols (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Jan. 1961. 42p. OTS.

An analytical study of temperature distributions on two disks subjected to solar radiation was made. The effect on the temperature distribution of absorptivity, thermal conductivity, and the spacing between disks was determined. The calculations show the possibility of using a movable shield as a temperature control device for a space vehicle. (auth)

6095 (PIBAL-471) PERTURBED BOUNDARY LAYER SOLUTIONS APPLIED TO THE WALL JET AND BLASIUS PROFILE. Martin H. Bloom and Martin H. Steiger (Brooklyn. Polytechnic Inst.). Oct. 1960. 39p. Project No. 9781. Contract AF49(638)-217. (AFOSR-TN-60-1340).

Two types of first-order perturbation solutions are investigated. In the first limiting case it is assumed that the zero-order solution is that of a wall jet with zero outer-velocity, and the first-order correction considers the effect of a small outer steamwise flow. The special case of the constant velocity is treated in detail. In the second limiting case the constant pressure Blasius solution is taken as the zero-order solution and the first-order correction is a wall jet type of flow. This investigation considers both two-dimensional and axially symmetric flows. (auth)

6096 (PIBAL-614) LAMINAR FLOW IN FINITE POROUS CHANNEL WITH VARIABLE INJECTION OR SUCTION. Koon-Sang Wan (Brooklyn. Polytechnic Inst.). Sept. 1960. 56p. Project No. 9781. Contract AF49(638)-445. (AFOSR-TN-60-1197).

An investigation was conducted to obtain the incompressible laminar flow characteristics in a channel with porous walls of finite length in which fluid is being injected or sucked through the channel walls. An approximate solution was obtained based on the variational principle which is expressed in terms of the given, but arbitrary, function characterizing the variation of the injection velocity at the porous walls for any given velocity profile at the entrance to the porous region. It depends on the Reynolds number R_ξ' and the nondimensional maximum injection velocity $\bar{v}_o$, both of which are based on a reduced maximum velocity at the

entrance. A similarity rule for the problem was then established, and numerical examples are given for the case where the entrance velocity profiles are inlet or parabolic and the injection velocity is a constant or varies linearly. The results of the flow characteristics for these examples for different values of $\bar{v}_o$ are presented in the form of curves. (auth)

6097 (R60SD439) EFFECTS OF END CURRENT LOOPS ON THE VELOCITY PROFILE IN A MAGNETOHYDRODYNAMIC CHANNEL. A. W. Carlson and G. W. Sutton (General Electric Co. Missile and Space Vehicle Dept., Philadelphia). Dec. 1960. 38p. Contract AF49 (638)-914. (AFOSR-TN-60-1183).

The effect of the end-current loops on the velocity profile in a magnetohydrodynamic flow was investigated for incompressible inviscid flow in a rectangular channel. The end-current loops interact with the applied magnetic field to produce Lorentz forces. In the entrance region of the channel, the Lorentz forces vary in magnitude and direction. This variation of the Lorentz forces causes the velocity of the fluid to increase near the walls of the channel and to decrease near the center. The ratio of the changes in velocity to the initial velocity is directly proportional to the interaction parameter $\sigma B\phi_0/\rho U^2$. For a value of $\sigma B\phi_0/\rho U^2 = 0.25$, the maximum change in velocity is 10% of the initial velocity. (auth)

6098 (TIL/BIB/20) BIBLIOGRAPHY ON AERODYNAMIC HEATING. (North Atlantic Treaty Organization, Paris. Advisory Group for Aeronautical Research and Development). Sept. 1957. 122p.

Compiled by Technical Information and Library Services, Ministry of Supply.

This bibliography includes 1196 references arranged in sections according to the year of publication, starting with 1957, and alphabetically by author within each section. Author and subject indexes are included. (W.L.H.)

6099 (WADC-TR-59-624) SURVEY OF BOUNDARY LAYER HEAT TRANSFER AT HIGH VELOCITIES AND HIGH TEMPERATURES. Ernst R. G. Eckert (Minnesota. Univ., Minneapolis. Heat Transfer Lab.). Apr. 1960. 114p. Project No. 7064. Contract AF33(616)-5676. OTS.

Heat transfer in boundary layer flow at high velocities and high temperatures is discussed, and engineering relations for its calculation are presented. Aeronautical and space flight applications have pushed the conditions under which heat transfer knowledge is important to much higher velocities and temperatures. This need for information created an intensive research effort, which is reflected in the large number of publications contained in appendix III of this report. By this research, the influence of very large temperature differences, of dissociation and ionization, of low densities, and of chemical reactions on heat transfer has been well established in its general features. In addition, new cooling methods, like transpiration, ablation, or film cooling have been studied. The reference enthalpy method, introduced in WADC TR 54-70, and well established in the meantime, is extended and generalized in this report to include the additional effects mentioned above. This leads to simple relations by which heat transfer can be calculated with an accuracy which should be sufficient for engineering purposes. These relations additionally have the advantage that most of them are applicable to any gas or gas mixture; and, therefore, not only to the reentry problem but also to heat transfer problems arising in rockets or other propulsion systems and in other applications. (auth)

6100 (AERE-Trans-854) EXPERIMENTS ON THE DETERMINATION OF THE MAXIMUM AND MINIMUM VALUES OF THE HEAT TRANSFERRED BETWEEN A METAL SURFACE AND BOILING WATER. S. Nukiyama. Translated by S. G. Brickley from Nippon Kikai Gakkai Shi 37, 367-74(1934). 21p.

Q, the quantity of heat transferred to boiling water from the surface of a metal, increases gradually according to the increase in the value of ΔT, the difference between the temperatures of water and metal, but when a certain point is reached, if ΔT increases above this, then Q, on the contrary, decreases. This point is the maximum value of what is referred to in the title hereof as "heat transferred" and, in this paper, the existence of a point such as this is verified experimentally. At atmospheric pressure, the ΔT corresponding to this point does not exceed 20 to 40°C at a water temperature of 100°C, and in this case Q reaches 30 to 50 cal/cm^2/sec, that is, 1,080,000 to 1,800,000 kcal/m^2/hr. If this is expressed as an equivalent evaporation rate at 100°C, it is 2000 to 3000 kg/m^2/hr, which shows a very much greater value for Q than the maximum value hitherto considered to exist. In addition, the minimum value (not the lowest value) for Q, corresponding to this maximum value, and which must exist, has been determined and report is made of the fact that the curve of the relation between ΔT and Q at regions of high temperature has a relationship with the effectiveness of quenching. (auth)

6101 (JPRS-7230) LIMITING PRINCIPLES OF HEAT TRANSFER IN AN INTERNAL PROBLEM AT LOW VELOCITIES. (Predel'nyi Zakon Teploperedache vo Vnutrennei Zadache pri Malykh Skorostyakh). Translated from Zhur. Eksptl', i Teoret. Fiz. 7, 1466-8(1937). 7p. OTS.

The heat transfer in a closed vessel filled with liquid is examined. All the vessel walls are impermeable by the liquid. A portion of the walls is thermally insulated, and the remaining areas are maintained at various temperatures. An analysis of the heat transfer between the areas which were heated to different temperatures is presented. (J.R.D.)

6102 HEAT TRANSFER BETWEEN MERCURY AND WATER FLOWING IN A CLOSELY PACKED ASSEMBLY OF RODS. V. I. Subbotin, P. A. Ushakov, B. N. Gabrianovich, and A. V. Zhukov. Atomnaya Energ. 9, 461-9(1960) Dec. (In Russian)

The heat transfer to mercury and water from closely packed rod assemblies is analyzed. The temperature distribution at the heat exchange surface was measured, and the experimental installation, the treatment methods, and the analysis of the data are described. An approximate calculation method was developed for a certain group of tightly packed rods. (tr-auth)

6103 SIMILITUDE METHODS APPLIED TO GENERALIZATION OF THE EXPERIMENTAL RESULTS ON CRITICAL HEAT FLUXES FOR BOILING LIQUIDS. S. S. Kutateladze and G. I. Bobrovich. Atomnaya Energ. 9, 493-4(1960) Dec. (In Russian)

An analysis is made on the aspects of two existing hypotheses on critical boiling. The first hypothesis postulates that the critical bubble density is determined by the same criteria as heat transfer in nucleate boiling, i.e., that in the event of boiling in a large volume of fluid heated to saturation the magnitude of the critical density is determined by the criterion function. The second hypothesis postulates that critical boiling is a special phenomenon related to the disturbances of hydrodynamic stability in

the two-phase boundary layer, reaching a critical rate of vapor formation. On the basis of the latter, a series of formulas was derived. Further, some constant coefficients were theoretically calculated. In the hydrodynamic theory the formula for boiling in a large volume of non-viscous saturated fluid is:

$$\frac{q\ cr.}{r\sqrt{g\gamma''(1+\frac{\gamma''}{\gamma})\sqrt[4]{(\gamma-\gamma'')}}} = K = \text{const, where K is of the order}$$

of 0.13 to 0.16. Calculations and experiments confirm the second hypothesis and the physical concept of the process. (R.V.J.)

6104 HEAT TRANSFER TO AN Na–K ALLOY IN AN ANNULUS. E. M. Khabakhpasheva and Yu. M. Il'in. Atomnaya Energ. 9, 494-6(1960) Dec. (In Russian)

Heat transfer coefficients in annuli were determined by measuring the temperature at a considerable distance from the channel entrance. The experiments were carried out with two-side and one-side heat supplies to 2.5, 3.5, and 4.5 mm annuli. The Nusselt criterion for narrow annuli ($d_1/d_2 \approx 1$) is about 25 to 30% less than for round tubes with identical Peclet values and is in good agreement with theoretical data. The Nusselt value for annuli (two-side heat supply at Peclet number exceeding 500) also agrees with theoretical data and exceeds by 1.3 to 1.5 folds the Nusselt number for round tubes. Consequently, the experiments confirm the theoretical postulation that the geometry of the channel and the means of heat supply influence heat transfer in heat carriers with small Prandtl numbers. (R.V.J.)

6105 THE THERMAL RESISTANCE OF A CONTACT. Yu. P. Shlykov and E. A. Ganin. Atomnaya Energ. 9, 496-8 (1960) Dec. (In Russian)

Calculations are presented on thermal conductivity at a contact between rough surfaces at various pressures. The calculated values are in good agreement with experimental data. (R.V.J.)

6106 FLOW CHARACTERISTICS OF DILUTE SMALL PARTICLE SUSPENSIONS. R. C. Cairns, K. R. Lawther, and K. S. Turner (Australian Atomic Energy Commission, Lucas Heights, New South Wales, Australia). Brit. Chem. Eng. 5, 849-56(1960) Dec.

A study was made of the dynamic behavior of small-particle suspensions because of interest in a power reactor fuel consisting of a fissile powder suspended in a liquid metal. Fissile uranium powder suspended in molten sodium was selected for a theoretical study. For a variety of pipe sizes and concentrations, data were obtained for water systems of red lead, barium sulfate, tungsten, and talc. The density of the solids was from 2.7 to 19.3 g/cc, and was readily available in the sub-sieve size range. The horizontal settling velocity was determined by reducing the flow rate and observing the point at which a moving bed appeared, as well as the point at which a stationary bed appeared for flow through a horizontal pipe, upward through a vertical pipe, and through a smooth 90° elbow. The results are given graphically as effective density ratio as a function of horizontal settling velocity. A radiometric method was used to measure concentration distributions and, to facilitate the measurements, the tungsten suspension was circulated through a pipe of square cross section. Graphical representations are given for concentration measurements across the horizontal pipe, across the center of the elbow, and across the vertical pipe for suspension velocities of ~3 ft/sec and ~13.5 ft/sec. The conclusions are discussed. (B.O.G.)

6107 USE OF STANDARD ANALOGUE TECHNIQUES IN SOLVING PROPAGATION PROBLEMS. A. Gadola (AGIP Nucleare, Milan), V. Gervasio, and C. Zaffiro. Energia nucleare (Milan) 7, 717-23(1960) Oct. (In English)

A partial differential equation describing transport phenomena is examined. A modal analysis leads to a system of ordinary differential equations which can be solved on a general purpose analog computer. A circuit arrangement enabling a simulation of pulse transmission at a variable speed along a channel is presented. (auth)

6108 TRANSIENT HEAT CONDUCTION IN A ROD OF FINITE LENGTH WITH VARIABLE THERMAL PROPERTIES. W. H. Chu and H. N. Abramson (Southwest Research Inst., San Antonio). J. Appl. Mech. 27, 617-22(1960) Dec.

A theoretical solution for transient heat conduction in a rod of finite length with variable thermal properties is presented. A numerical procedure is developed and the results of one example are presented and compared with the corresponding solution for the case of constant properties. Application to the problem of determination of thermophysical properties is discussed. (auth)

6109 AN ACCURATE EXPRESSION FOR GAS-PRESSURE DROP IN HIGH-SPEED SUBSONIC FLOW WITH FRICTION AND HEATING. R. H. Fox (Univ. of California, Livermore). J. Appl. Mech. 27, 747-8(1960) Dec. (UCRL-5804).

An approximate solution is derived for the pressure ratio in high-speed subsonic flow through constant-cross-section circular tubes with friction and heating. The results are compared with those obtained from an accurate numerical calculation. The gas used is air. A wide range of variables such as temperature ratio, exit Mach number (up to 0.90), tube length-to-diameter ratio, and shape of the power distribution function is examined. The derived expression is found to be quite accurate in all cases. (auth)

6110 FLOW OF LIQUID METAL PAST A POROUS FLAT PLATE. G. Horvay (General Electric Co., Schenectady, N. Y.). J. Appl. Mech. 27, 749-50(1960) Dec.

A boundary-layer approximation formula is derived for the temperature distribution in liquid metal which flows past a porous flat plate at zero incidence at velocity U and is sucked into it at velocity V. (auth)

6111 THE FLUID FLOW RESISTANCE THROUGH THE ROUND TUBE IN NET BOILING. Kinichi Torikai, Masao Hori, and Toshi Yamasaki (Japan Atomic Energy Research Inst., Tokyo). J. Atomic Energy Soc. Japan 2, 671-81(1960) Nov. (In Japanese)

The fluid flow resistance through round tubes in boiling is different from two-phase flow, but it is not well identified. It is definitely shown from semi-theoretical analysis and experiments in net boiling of forced flow in 20 ϕ tube at 3 to 13 m/sec, 2 to 150 atm, and in 1 to 4 × 10^6 kcal/m^2hr, turbulence of flow by turbulent energy based upon the detachment from the tube wall and growth of the bubbles is generated, and the fluid flow resistance is also changed. But this turbulence is not larger than the turbulence of normal flow in tubes except in cases of low flow velocity or low pressure, and this effect is negligible in practice. Then the coefficient of frictional flow resistance through the round rough tube in normal turbulent flow is available in high velocity flow at high pressure in net boiling too. (auth)

6112 THE APPLICATION OF STATISTICAL METHODS OF ANALYSIS FOR PREDICTING BURNOUT

HEAT FLUX. R. T. Jacobs and J. A. Merrill (Phillips Petroleum Co., Idaho Falls, Idaho). Nuclear Sci. and Eng. 8, 480-96(1960) Dec.

The comparative correlations of this report thoroughly demonstrate that significantly more precise equations for calculating burnout heat flux can be obtained by following the proposed "system-describing" concept, that if the independent, system-describing variables of a system are known, the burnout heat flux can be predicted. With this concept, the independent variable of inlet temperature was used rather than the dependent variable of outlet subcooling or enthalpy. The same statistical (regression analysis) method of correlation was used for burnout data from several sources with both inlet temperature and outlet enthalpy so that the consistently better predictions using inlet temperature would not be attributed to using a different method of correlation. The fact that reactor technology and design no longer allow the engineer safety factor added upon safety factor, a decided advantage of the regression analysis correlation is that it is possible to calculate the statistical uncertainty of the predicted burnout heat flux. (auth)

6113 HEAT TRANSFERRED FROM REACTOR CORE TO COOLANT. S. B. Menkes (Nuclear Development Corp. of America, White Plains, N. Y.). Nucleonics 18, 170(1960) Nov.

A graph that provides a rapid and reasonably accurate method of ascertaining the cumulative fraction that is transferred from a reactor core to the coolant is presented. (M.C.G.)

6114 HEAT TRANSFER AND SKIN FRICTION IN MAGNETO-GAS DYNAMIC CHANNEL FLOW. F. D. Hains (Boeing Scientific Research Labs., Seattle). Presented at the ARS Semi-Annual Meeting and Astronautical Exposition, Los Angeles, California, May 9-12, 1960. New York, American Rocket Society, 1960. 35p.

An integral method is developed for the laminar boundary layer on the wall of a circular channel when the flow interacts with a magnetic field produced by a single loop of wire surrounding the channel. Using the previous results obtained by the method of characteristics for the inviscid external flow, numerical solutions are obtained. The skin friction and heat-transfer rates are compared to the values for the case of nonmagnetic interaction. Comparison is also made with measurements made in a shock tube. (auth)

Instrumentation

6115 (AEDC-TN-60-30) INVESTIGATION OF A WELDABLE TYPE, HIGH-TEMPERATURE STRAIN GAGE FOR MEASUREMENT OF STRAIN BY ELECTRICAL MEANS AT TEMPERATURES UP TO 600°F. Guy J. Gardner and Ernest E. Newman (Arnold Engineering Development Center, Tullahoma, Tenn.). Jan. 1960. 29p. ARO Project No. 246811. Contract AF40(600)-800.

An investigation was conducted to determine whether or not a weldable strain gage could be used to measure high thermal strain on structural steel members at temperatures up to 600°F. The gages as received from the manufacturer required temperature cycling before their change in resistance with temperature became repeatable. After gages were cycled and stabilized, the resistance of some gages increased with temperature whereas that of others remained close to their initial value or decreased. Thus random selection of gages for temperature compensated bridges could result in considerable mismatch. The tests indicated that unbonded strain data can be used to predict the apparent strain of bonded gages to within 0.07 to 0.4 micro-in./in./°F for temperatures up to 600°F. Gage factors were found, in general, to be lower than those specified by the manufacturer and to decrease from 2.5 to 7.5% with temperature at 600°F. (auth)

6116 (HW-58538) DESIGN TEST PR-60—RESISTANCE TEMPERATURE DETECTORS. Final Report. R. G. Clark (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan 1, 1959. 30p. Contract AT(45-1)-1350. OTS.

A clamp-on resistance temperature detector was developed for the Plutonium Recycle Test Reactor. The units were tested for sensitivity; accuracy; time of response; electrical insulation; response to surface air drafts; and performance after exposures to radiation, temperatures of 725°F, and extended thermal cycling. It is recommended that these units, because they are a recent development, continue on test for as long as it is reasonable and practical. (auth)

6117 (NAA-SR-4709) PRESSURE AND TEMPERATURE INSTRUMENTATION FOR DYNAMIC MEASUREMENTS IN THE KEWB PROGRAM. A Summary Report. Sigmund P. Harris and Carle F. Bumpus, Jr. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 15, 1960. 77p. Contract AT(11-1)-GEN-8. OTS.

After an experimental survey of eight different models of pressure transducers, a system with fast response was developed to measure pressures in the KEWB reactor. The transducers used in the system operate in an environment which presents a high radiation level but which has temperatures that are quite low for a reactor. Thus they would not be suitable for use in a power reactor because of the temperature limitation. Since installation of this pressure-measuring system in the KEWB reactor, the recombiner tests and transient experiments have been completed, and observations have been made of explosion pressures. Two very useful pieces of special equipment were developed in the course of this project. One was the remotely controlled shock tube, which was used for testing transducers and was operable in the reactor through-tube. The other was the dual DADEE circuit developed to compensate for ringing and insufficiently fast response in transducers with two degrees of freedom. (auth)

6118 (NADC-AW-N5921) LOW-LEVEL RADIOACTIVITY MEASUREMENTS WITH AN INTEGRATING ELECTROMETER. Charles W. Fay (Naval Air Development Center. Anti-Submarine Warfare Lab., Johnsville, Penna.). Nov. 3, 1959. 20p. (AD-239252)

A detailed description is presented of the design of a large volume ionization chamber which can be used to detect extremely low-level radioactivity (natural background). The modification of a sensitive electrometer is also described. The electrometer is of the recording type and enables integration (total dosage) of ionizing radiations produced from a wide energy range of γ rays and β particles. (auth)

6119 (NBS-6709) THE POWER SPECTRUM AND ITS IMPORTANCE IN PRECISE FREQUENCY MEASUREMENTS. J. A. Barnes and R. C. Mockler (National Bureau of Standards. Boulder Labs., Boulder, Colo.). July 18, 1960. 35p. NBS Project 8440-12-84105.

The power spectral density functions of a frequency multiplier chain, driven by several different crystal oscillators, were obtained by comparing the output with a

second chain that was stabilized with an ammonia maser. The frequency of the maser stabilized chain was demonstrated to be relatively fixed; the power spectrum of the other chain was determined by two different methods. The results are compared. Possible errors and uncertainties introduced by the methods are discussed. An analysis is made that relates the instantaneous frequency fluctuations of a signal with the power spectral density function. Analysis predicts that when frequency modulation occurs in the first stages of frequency multiplication or in the primary frequency oscillator, the output power spectrum is, in general, not symmetrical. Furthermore, the sidebands are increased in intensity by the multiplication process. This is, in fact, observed to be the case. It is shown that a frequency counter will measure the frequency of the center of gravity of the power spectrum. If signals having a complex power spectrum are used in precise frequency measurements, errors may result. (auth)

6120 (NP-9484) SLOW-NEUTRON CROSS-SECTION WORK AT BR-1. H. Ceulemans and A. Deruytter (Mol, Belgium. Centre d'Étude de l'Énergie Nucleaíre). Oct. 1960. 12p.

Presented at "Agence Internationale de l'Energie Atomique. Colloque sur la Recherche en Physique au Moyen des Neutrons Émis par les Piles, Vienne, 17-21 Octobre 1960."

The slow chopper and crystal spectrometer associated with the BR-1 reactor are described. The rotor is a Fermi type consisting of alternate aluminum and cadmium plates with a slit width of 1 mm, a length of 59 mm, and its dimension parallel to the rotating axis is 170 mm. It is driven by a two-phase asynchronous motor powered by a VFO and output amplifier. Motor speed is variable from 900 to 15,000 rpm with a stability of 0.1% for short periods and 0.5% for several days. Resolution and accuracy are shown by data giving the abrupt cross-section change for the (110) planes in α iron, (101), (002) in graphite, and (100), (101) in beryllium. A new determination of σ_f of U^{235} gave a value of 587 ± 6 b at 2200 m/s. The crystal spectrometer is using the (111) planes of a copper crystal until the beryllium crystal arrives. The spectrometer arrangement is briefly described. (T.R.H.)

6121 (NP-9748) SOFT X-RAY PHOTON COUNTER—STABILIZATION OF SOURCE. Technical Report No. 4. D. H. Tomboulian (Cornell Univ., Ithaca, N. Y.). Nov. 1960. 14p. Contract Nonr-401(37).

An analysis is presented of the design and performance of a soft x ray counter. Schemes adopted for regulating the x-ray tube current and potential are described. Descriptions and block diagrams are included for the power supply, voltage regulator, and current regulator. A simplified analysis is described and illustrated of the behavior of the current control circuit. (C.H.)

6122 (NP-9749) RAPID MEASUREMENT OF THERMOELECTRIC MATERIALS UNDER SIMULATED GENERATOR CONDITIONS. Research Report 431FD406-R1. S. J. Angello and C. S. Duncan (Westinghouse Electric Corp. Research Labs., Pittsburgh). Jan. 15, 1959. 17p.

Design features are presented for a thermoelectric generator material tester. The test apparatus was found to be fast and sufficiently accurate for evaluating and selecting thermoelectric generator materials. Illustrative data are included on ZnSb and InSb. Complete detail drawings are included. (C.H.)

6123 (NYO-9401) NUCLEAR TRACK IMAGE INTENSIFIER. First Quarterly Report, June 1, 1960 to August 30, 1960. R. D. DesRochers, H. A. Stern, and L. A. Ezard (Radio Corp. of America. Electron Tube Div., Harrison, N. J.). Sept. 30, 1960. 25p. Contract AT(30-12)2591. OTS.

Development of a nuclear track image intensifier which is to have a cathode dia. of 83 in. and an output screen dia. of 1 in. is reported. Spherical faceplates for the intensifier which were etched to a thickness of 0.025 in. over a dia. of 80 in. withstood a pressure differential of 2 atm. Techniques were developed to measure spectral energy distribution, phosphor burn characteristics, phosphor efficiency, and phosphor persistence. Thallium-activated RbI and CsI were evaluated for use in the first stage of the image intensifier system. A color shift toward the yellow was accomplished in rubidium iodide phosphor by increasing the mole % of Th activator. Burn varied widely in different samples. (C.J.G.)

6124 (ORNL-3016(p.130-6)) A NEUTRON CHOPPER SPECTROMETER FOR THE BULK SHIELDING FACILITY. V. V. Verbinski (Oak Ridge National Lab., Tenn.).

The preliminary design of a neutron chopper spectrometer for the BSF, to be located underground adjacent to the pool of the BSR, was completed. The spectrometer will have a flight path of about 10 m, which, with the chopper rotor currently proposed, will give energy resolutions ranging from ~3% for energies below 10 ev through 10% at 100 ev to ~30% at 1000 ev. A stack of high-pressure BF_3-counters will serve as the detector, with pulses going to a 256-channel time-of-flight analyzer. Read-out will be in the form of punched tape coded for the Oracle, which will transform the time-of-flight data to neutron-energy spectra. (auth)

6125 (ORNL-3016(p.249-54)) UNSCRAMBLING OF SCINTILLATION SPECTRA. R. O. Chester and W. R. Burrus (Oak Ridge National Lab., Tenn.).

A method of automatically processing pulse-height data obtained as the output of a scintillation spectrometer in a spectrum of γ rays is being developed. The method makes no prior assumptions about the spectrum being examined. Semiempirical functions are used to fit the experimentally determined response of the spectrometer to monoenergetic γ rays. Simple power-function fits, as a function of energy, to the parameters of the response function are used to develop the response matrix. Solutions to the result-matrix equations are being investigated. Special techniques are necessary to get useful results. Numerical tests using a nonnegativity constraint were made, and tests are in progress using a smoothing function. (auth)

6126 (ORNL-3016(p.264-6)) THE MODEL IV GAMMA-RAY SPECTROMETER: STATUS REPORT. G. T. Chapman (Oak Ridge National Lab., Tenn.).

Assembly of the Model IV γ spectrometer was completed, with only final calibration of the positioner and readout system yet to be accomplished. A series of preliminary investigations of the system performance, utilizing a 9-in.-diameter by 12-in.-long composite NaI(Tl) scintillator as the γ detector, is in progress. These experiments will assist in optimizing performance of the spectrometer system. Comparisons with calculations are being used as guides to further improvement. (auth)

6127 (PG-Report-160) A SLOW-SCAN DIRECT-READING SPECTROMETER FOR URANIUM ISOTOPE ANALYSIS USING A WATER-COOLED HOLLOW CATHODE

SOURCE. R. Orrell (United Kingdom Atomic Energy Authority. Production Group. Windscale, Sellafield, England). 1960. 9p. BIS.

The design and construction of a direct reading Echelle spectrograph for determining uranium isotope ratios up to 150:1 are described. From 15 to 25 samples per 8-hour day can be analyzed. The precision (3σ) of determination of 93% U^{235} is ±0.05%. A new type of water-cooled hollow cathode excitation source is also described. (auth)

6128 (SC-4519(RR)) INTERIM REPORT ON DEVELOPMENT OF DESIGN CRITERIA FOR RELAYS. Period covered: June 1, to July 31, 1960. (Oklahoma State Univ., Stillwater. School of Electrical Engineering). Nov. 1960. 85p. For Sandia Corp. OTS.

Work is reported on the experimental verification of theoretical solution for relay transit time, experimental verification of relay seating time, relations governing relay operation and the problems involved in obtaining a general design procedure from these relations, influence coil dimensions on the pickup time and magnetic pull, relations governing relay design as imposed by the transit analysis study, and some equivalent representations of magnetic reluctance. (W.L.H.)

6129 (SCTM-69-59(15)) THE ELCO TRANSLATOR. E. C. Dowling and W. K. Paulus (Sandia Corp., Albuquerque, N. Mex.). Nov. 9, 1959. 34p. OTS.

The ELCO (Eliminate and Count) Word Code Translator is a semiconductor, digital logic device used to automatically encode conventional English words into unique four-character 20-bit binary words for optimum storage and searching. Intended to be used as an element of a high-speed automated retrieval system, it allows the machine operator to talk to the retriever in clear English instead of some arbitrarily prepared, manually coded system, thus eliminating code books and table look-up. For discussion of the higher order electronic retrieval system, refer to the "Rapid Retriever," SCTM 247-59(15). For the basic principles involved in autoencoding by eliminate and count methods, refer to "The ELCO Translation," SCTM 249-59(15). (auth)

6130 (SUI-60-12) THE DEVELOPMENT OF A CORPUSCULAR RADIATION EXPERIMENT FOR AN EARTH SATELLITE (thesis). George H. Ludwig (Iowa. State Univ., Iowa City). Aug. 1960. 324p. Sponsored by NASA; ONR; and AEC under Contract NASw-17 and N9-onr-93803. OTS.

The satellite S-46 payload system was developed to study the belts of high intensity radiation surrounding the earth. In particular, it was designed to monitor the spatial and temporal intensity structure to a radial distance of about seven earth radii and for a one year period, to permit a crude study of particle composition and energy spectra, and to provide the first exploratory study of the very low energy component of the trapped radiation. The payload consisted of five detectors and their high voltage power supplies, electronic circuits to count and encode their outputs, a telemetry system, and a solar and chemical battery power system. The factors influencing the selection of the payload configuration and the satellite orbit are discussed, and a detailed description of the instrumentation is included. The satellite launch attempt on Mar. 23, 1960, failed due to improper functioning of the second-, third-, and fourth-stage rocket assembly. Operation of the instrumentation during the nine minute launch trajectory was, however, completely satisfactory. The detectors and electronics system are still believed capable of fulfilling the initial objectives, and a new set of instruments utilizing similar detectors is being prepared for flight in another satellite-launch vehicle configuration in 1961. (auth)

6131 (SUI-60-14) A SATELLITE BORNE MAGNETIC ELECTRON SPECTROMETER (thesis). Curtis D. Laughlin (Iowa. State Univ., Iowa City). Aug. 1960. 88p.

The design, construction, and calibration of satellite borne magnetic spectrometers for the measurement of the absolute intensity of electrons in a well defined energy interval, centered at about 50 kev, are described. The three spectrometers of the final design were experimentally calibrated with various β-ray sources and with monoenergetic electrons from a small accelerator. Their geometric factors were about 2×10^{-5} cm^2 steradian for electrons in the energy range 45 to 55 kev. The geometric factors were less than 2% of this value for electrons of energy less than 40 kev or greater than 60 kev (but less than 10 Mev). The counting rate due to electrons, protons, and other energetic ions capable of penetrating the 5.6 g/cm^2 shielding was determined by a geiger tube similar to the one in the spectrometer, similarly shielded and similarly located in the satellite assembly, but not provided with an entrance aperture. One of the spectrometers was flown as a component of the S-46 payload on 23 March 1960. Due to failure of the high speed stages of the Juno II vehicular system the payload was not placed in orbit. During some 8 min of recorded flight data, the two geiger tubes operated properly, counting cosmic rays. The peak altitude of 370 km was not sufficient to permit measurement of a significant intensity of geomagnetically-trapped electrons. A similar instrument is planned for a future satellite. (auth)

6132 (TID-7591(p.10-17)) USE OF ALPHA PULSE-HEIGHT ANALYZER IN ENVIRONMENTAL MONITORING. E. L. Ray and S. E. Hammond (Dow Chemical Co. Rocky Flats Plant, Denver). (RFP-163).

The use of a 100-channel pulse-height analyzer is described for identification and estimation of long-lived α contamination in environmental samples. Various applications are described. It is concluded that α pulse-height analysis provides a convenient method of identification and estimation of the α emitters present in a sample. Its chief advantage lies in the minimal operator time required as compared with differential chemical analyses. The method is extremely versatile. In addition to its use in environmental monitoring problems, it can be used as a tool in bio-assay determinations, bio-assay and analytical methods development, waste disposal problems, production development, and production control. (C.H.)

6133 (UCRL-9423) ELECTRON-ELECTRON COINCIDENCE SPECTROMETER BRS-IV. John P. Unik (California. Univ., Berkeley. Lawrence Radiation Lab.). May 1960. 41p. Contract W-7405-eng-48. OTS.

The original construction and recent modifications of the BRS-IV electron-electron coincidence spectrometer are summarized, and instructions for its use are given. The original spectrometer consisted of two collinear thin-lens β spectrometers back-to-back. The whole was iron-free, and Helmholtz coils were used to negate the effect of the earth's magnetic field. The spectrometer was designed for a 1% transmission with a 2% resolution. It became necessary to modify the instrument because of its low transmission and because a new coincidence circuit was needed for higher counting rates. The modification decreased the source-to-detector distance from 100 to 40 cm and increased the maximum solid angle accepted from the source from 0.4% to 4% of 4π. (T.R.H.)

6134 (UNM-PR-EE-21) CANCELLATION OF THE INDUCED VOLTAGE IN THE HALL GENERATOR. Jerrel Lochner and Laurence L. Rosier (New Mexico. Univ., Albuquerque. Engineering Experiment Station). July 20, 1960. 7p. For Sandia Corp. (SCDC-2176). OTS.

A simple and effective method is described for induced voltage compensation for a Hall generator. (W.L.H.)

6135 (UNM-TR-EE-33) HIGH-FREQUENCY TRANSISTORS: SMALL-SIGNAL PROPERTIES AND THEIR INTERPRETATION BY MEANS OF CIRCUIT MODELS. Bill J. Harper (New Mexico. Univ., Albuquerque. Engineering Experiment Station). June 1960. 56p. For Sandia Corp. OTS.

The small-signal properties of high-frequency transistors were investigated. The primary objective was the derivation of circuit models (or equivalent circuits) which accurately describe the electrical behavior of transistors over a wide frequency range. An investigation of a transistor operating as a small-signal device is described along with conventional step-junction triodes having a uniform base impurity distribution. Graded-base or drift transistors that have an exponential impurity distribution in the base region are also discussed. Small-signal four-pole parameters of intrinsic transistors are derived in which only the diffusion mechanism is investigated. Small-signal parameters and circuit models for complete transistors are also derived. This derivation consists of the addition of the extrinsic elements to the small-signal parameters which were previously derived. The extrinsic elements considered include the parasitic and barrier capacities and the three lead resistances. Several circuit models are presented which are valid over specified frequency ranges. In addition, common-emitter and common-collector circuit models and small signal parameters are derived. These results are developed from the results presented earlier through the use of the matrix interrelations between the three configurations. A brief description of the experimental portion of the research is included. (auth)

6136 (WADD-TR-60-364) AN INVESTIGATION OF THE RESPONSE OF PHOTOMULTIPLIER TUBES. Perid covered: September 1957 to August 1958. Gordon H. Griffith (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). Aug. 1960. 17p. Project No. 6002. OTS.

The response of a photomultiplier tube is related to its average sensitivity and can be improved by using only the most sensitive part of the photocathode. A number of graphs are presented to illustrate the response of a photomultiplier tube as a function of the point on the photocathode surface that is illuminated and to indicate the improvement in symmetry of the isosensitivity lines that may be achieved by varying the shield voltage. While the observed sensitivities were due primarily to the geometry of the cathode-dynode configuration, they were also due partially to the nonuniform response of the cathode surface. (auth)

6137 (AERE-Trans-857) CRYSTAL COUNTERS OF CADMIUM SULPHIDE WITH A HIGH-FREQUENCY ELECTRIC FIELD. M. Borisov and M. Marinov. Translated by O. Routledge from Compt. rend. acad. bulgare sci. 11, No. 3, 169-72(1958). 7p.

A preliminary report is presented on the possibilities of using certain radiospectroscopic methods in association with crystal counters for registering nuclear radiation. The method involves pulse generation by crystal counters with elimination of polarization phenomena by using a high-frequency voltage. The effectiveness of the method was checked using CdS single crystals. (T.R.H.)

6138 METHODS OF DIRECTIONAL RECORDING FOR GAMMA RAYS. V. P. Bovin. Atomnaya Energ. 9, 483-7 (1960) Dec. (In Russian)

The basic characteristics and parameters of a directional radiation receiver are analyzed. Scintillation radiometers of the directional compensation type are studied and their advantages over similar gas discharge counters are stressed. Descriptions are given of various compensation systems for detecting and measuring radioactive elements. (tr-auth)

6139 DEVELOPMENT OF SWITCHING TUBES FOR CONTROLLED FUSION RESEARCH. D. B. Cummings (Univ. of California, Berkeley). Elec. Eng., 5p.(1960) Nov.

Conventional ignitrons required extensive improvements to increase their current and voltage ratings to the high values required for controlled nuclear fusion research. A 4-year program to develop these improved tubes and the results achieved are described. (auth)

6140 SIGNAL TO NOISE RATIO AND RESOLVING TIME IN PULSE AMPLIFIERS FOR NUCLEAR DETECTORS. F. T. Arecchi (Centro Informazioni Studi Esperienze, Milan), G. Cavalleri, E. Gatti, and V. Svelto. Energia nucleare (Milan) 7, 691-6(1960) Oct. (In English)

A derivation is given for an equation for determining the maximum signal-to-noise ratio in pulse amplifiers. The upper limits of this ratio were calculated for amplifiers used in connection with radiation detection considering a given resolving time. The results of the calculations are given graphically for various cases involving variations in the current pulses and white noise spectra. (B.O.G.)

6141 STATISTICAL LIMITS IN TIMING WITH SLOW SCINTILLATORS. F. T. Arecchi (Centro Informazioni Studi Esperienze, Milan), A. De Matteis, and E. Gatti. Energia nucleare (Milan) 7, 697-700(1960) Oct. (In English)

With reference to previous works on timing with scintillation counters, results on variances in time measurements are extended to the case of slow scintillators as NaI(Tl), for two different methods of timing. The systematic dependence of machine time on the amplitude of the scintillation (the so-called "machine time walk") is given. (auth)

6142 A HIGH EFFICIENCY GEIGER MÜLLER COUNTER FOR MEASURING FLOWING RADIOACTIVE LIQUIDS. F. Gadda and G. Redaelli (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan) 7, 701-4(1960) Oct. (In English)

A high efficiency Geiger Mueller counter for measuring flowing radioactive liquids was devised. Technological details of construction are reported. The counter was filled with a neon-argon mixture, using bromine as quenching agent; it shows quite good working characteristics. The efficiency of the counter for various β-emitters with maximum energy ranging from 0.3 to 2.2 Mev was plotted. At the highest energy investigated (Y^{90}: E_{max} = 2.21 Mev) an efficiency greater than 50% is obtainable. (auth)

6143 A NUCLEAR MAGNETOMETER. G. Faini, A. Fuortes, and O. Svelto (Istituto de Fisica del Politecnico, Milan). Energia nucleare (Milan) 7, 705-16(1960) Oct. (In English)

A description is given of the design and the testing of an apparatus for the measurement of the earth's magnetic

field, based on the principle of nuclear induction. The method uses a prepolarization technique introduced by Packard and Varian that has proved to be best suited for measurements of weak magnetic fields; this method differs from that of Packard and Varian, because of the relatively strong prepolarization of the nuclear sample, followed by a small and sharp "rotation" field. Particular care was given to the maximization of the signal-to-noise ratio, and to the extraction of the maximum information from the nuclear signal. In this way, it was possible to obtain an accuracy of 10^{-5} for absolute measurements and 10^{-6} for relative ones. The results of some measurements are discussed. (auth)

6144 ON THE ABSOLUTE CALIBRATION OF A Ra–Be NEUTRON SOURCE. G. P. Felcher (Centro Informazioni Studi Esperienze, Milan), E. Germagnoli, and M. Musci. Energia nucleare (Milan) 7, 738(1960) Oct. (In English)

During measurements with a Ra–Be neutron source, it was found that the rod used to support flux detection foils had a large capture cross section for slow neutrons that caused a drastic reduction in the neutron flux in the proximity of the foils. Measurements were made using a nonabsorbing rod and comparisons were made to previous measurements. The strength of the source was redetermined as: $Q = (7.69 \pm 0.27)10^6$ neutrons/sec. Considering the growth of polonium in the source, the strength is: $Q = (7.73 \pm 0.27)10^6$ neutrons/sec. Intercomparisons with other calibrated sources are in progress to check these results. (B.O.G.)

6145 A SIMPLE METHOD OF ABSOLUTE BETA COUNTING BY SCINTILLATION TECHNIQUE. M. G. Shahani (Atomic Energy Establishment, Trombay, India). J. Sci. Ind. Research (India) 19B 461–4(1960) Dec. (In English)

A method of determining β activity using plastic scintillators is described. The low energy part of the spectrum for P^{32} is obtained by a linear extrapolation of the experimental plot of the β spectrum. Since only one photomultiplier is needed, the method is simple and the experiment can be carried out at room temperature without the additional equipment usually needed for cooling the phototube. The method gives consistent results at 600 to 900 v. (auth)

6146 A METHOD OF MEASURING ACTIVITY IN BIOLOGICAL OBJECTS WITH THE AID OF SCINTILLATING GEL. L. G. Shakhidzanyan, D. G. Fleishman, V. V. Glazunov, V. G. Leontiev, and V. P. Nesterova (Sechenov Inst. of Evolution Physiology, USSR). Med. Radiol. 5, No. 10, 72-4(1960) Oct. (In Russian)

A highly sensitive method is suggested for measuring the β activity of biological ashes. The radioactivity is measured by counting suspensions in a scintillating jelly prepared by adding 5 wt. % plexiglas to an ordinary liquid scintillator. The recording equipment consists of a photomultiplier, linear amplifier, integral discriminator, and checking device. The background in a 5-cm-thick lead shield at the 70-kev discrimination level is 29 pulses/min. The efficiency for K^{40} β particles is ~98% and for Sr^{90} + Y^{90}, ~91%. (R.V.J.)

6147 AN ULTRA-SENSITIVE IONIZATION DETECTOR FOR PERMANENT GAS ANALYSIS. R. Berry (Culcheth Labs., Lancs, Eng.). Nature 188, 578-9(1960) Nov. 12.

Using a molecular sieve 5A column of 4 mm diameter and 30 cm long, it is possible to determine <0.001 μl of hydrogen, argon, oxygen, nitrogen, methane, and carbon monoxide in <2 min. Up to 1 μl of gas can be determined before the detector is saturated. The column is operated at room temperature, except when oxygen-argon mixtures are analyzed, when cooling to −80°C is required. The limit of detection is $\sim 10^{-12}$ mole of component per milliliter of carrier gas. (B.O.G.)

6148 A NEW TYPE OF NEUTRON SPECTROMETER. Richard L. Bramblett, Ronald I. Ewing, and T. W. Bonner (Rice Univ., Houston, Tex.). Nuclear Instr. & Methods 9, 1-12(1960) Oct. (In English)

Neutrons were detected in a small $Li^6I(Eu)$ scintillator placed at the center of polyethylene moderating spheres with sizes ranging from 2 to 12 in. in diameter. The efficiency of this neutron counter was experimentally determined using monoenergetic neutrons from thermal energies to 15 Mev. The counter has excellent energy sensitivity from 0.1 to 2 Mev and is particularly useful for determining the shapes of continuous neutron spectra. The pronounced difference in the efficiencies for the five sizes of spheres which were calibrated provides a basis for accurate neutron energy determination. The good γ ray discrimination of the counter allows it to be used with a radium-beryllium neutron source. Neutron spectra from a variety of sources were determined with this counter. These include the two groups of neutrons from the $C^{14}(p,n)N^{14}$ reaction, the evaporation spectrum of the neutrons from the reaction $Rh^{103}(p,n)Pd^{103}$, the energy spectra of inelastically scattered neutrons, and the neutron spectrum from the scattering of fast neutrons by the floor and walls of a building. (auth)

6149 NOTES ON A FAST TIME ANALYZER FOR SHORT LIFETIME MEASUREMENTS. M. Bonitz and E. J. Berlovich (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Nuclear Instr. & Methods 9, 13-20(1960) Oct. (In English)

A critical comparison of the single- and multichannel method for short lifetime measurements of excited states in nuclei is given. A new time-to-height converting system, based on the pulse overlap principle of a biased diode discriminator, was constructed. The time resolution of the prompt $\gamma-\gamma$ coincidence curve from a Co^{60} source is 5×10^{-10} sec. The influence of the energy of the coinciding particles on the performance of the time analyzer, and a stability control method are discussed. Experimental results are given for the following excited levels: 145 kev in Pr^{141}, $T_{1/2} = (2.0 \pm 0.2) \times 10^{-9}$ sec; 279 kev in Tl^{203}, $T_{1/2} = (2.9 \pm 0.2) \times 10^{-10}$ sec, and 411 kev in Hg^{198}, $T_{1/2} = (3.5 \pm 0.8) \times 10^{-11}$ sec. (auth)

6150 AUTOMATIC MASS NUMBER DETERMINATION FOR ISOTOPE SEPARATORS AND MASS SPECTROMETERS. L. Wåhlin (National Physical Research Lab., Pretoria). Nuclear Instr. & Methods 9, 21-8(1960) Oct. (In English)

Automatic mass number determinations for isotope separators and mass spectrometers are possible by means of an electronic computer system. A detailed description of this method, as applied to the isotope separator in Pretoria, is given. (auth)

6151 MEASUREMENT OF TIME IN THE NANOSECOND REGION: TIME TO AMPLITUDE CONVERTER AND COINCIDENCE CIRCUITS. R. Ballini and E. Pomelas (Centre d'Etudes Nucléaires, Saclay, France). Nuclear Instr. & Methods 9, 29-36(1960) Oct. (In French)

A time-to-pulse height converter, associated to a pulsed accelerator was improved by using an electron beam switching tube and a convenient shaping of photomultiplier pulses. Such pulses were applied to a transistorized millimicrosecond coincidence circuit. (auth)

6152 A NEW TYPE OF ČERENKOV DETECTOR FOR THE ACCURATE MEASUREMENT OF PARTICLE VELOCITY AND DIRECTION. Arthur Roberts (Univ. of Rochester, N. Y.). Nuclear Instr. & Methods 9, 55-66 (1960) Oct. (In English) (NYO-9090)

A new type of Čerenkov radiation detector is proposed, in which the light emitted by a single particle traversing a radiator is imaged, by means of a lens or mirror focused at infinity, on the cathode of an image-intensifier tube. The image is a ring, whose diameter measures accurately the Čerenkov cone angle, and thus the particle velocity. In addition the coordinates of the center of the circular image accurately indicate the orientation of the particle trajectory (though not its position). The sensitivity of presently available systems of cascaded image-intensifier tubes allows the photographic recording of the image produced by a single particle. The system is inherently insensitive to background noise. It can observe simultaneously several incident particles whose directions span a wide angle. It may be gated with microsecond coincidence resolving times. It can use condensed or gaseous radiators; with the former, chromatic dispersion is likely to limit the accuracy. For gas radiators, the attainable accuracy of velocity determination is estimated as $\Delta\beta = \pm 0.0002$ or better; the accuracy of track orientation ± 0.001 radians. The range of velocity and orientation simultaneously observable depends on the angular field of view of the objective. Sources of error, the precision attainable, the design of practical systems and some possible applications are discussed. (auth)

6153 APPARATUS AND ANALYSIS FOR SUM-COINCIDENCE (n,γ) SPECTROMETER. J. E. Draper and A. A. Fleischer (Yale Univ., New Haven). Nuclear Instr. & Methods 9, 67-77(1960) Oct. (In English)

Apparatus is described for analyzing two-step cascades of neutron capture γ rays by the sum-coincidence method and consideration is given to the types of results which can be obtained. A detailed analysis is given of detection efficiency and peak shapes and their dependence on the characteristics of the sum discriminator. Several background effects are analyzed quantitatively such as back-scattering between scintillators, annihilation photon transfer between scintillators, cascades which terminate only near to the ground state, three-photon cascades, and uncertainties caused by unknown angular correlations. (auth)

6154 A SEMI-AUTOMATIC ANALYSER FOR BUBBLE CHAMBER PHOTOGRAPHS. O. R. Frisch and A. J. Oxley (Cavendish Lab., Cambridge, Eng.). Nuclear Instr. & Methods 9, 92-6(1960) Oct. (In English)

Photographs of nuclear particle tracks can be accumulated rapidly with fast-cycling bubble chambers. This article describes a machine for measuring the photographs quickly so that the subsequent computations can be done with an electronic computer. The films are projected onto a ground glass screen bearing a reference mark, and moved by hand through a pantograph to bring interesting points onto the mark. The pantograph carries a plate with a fine square lattice of dots, and four photocells serve to digitize its X and Y coordinates. The two stereoscopic images of a point can be merged by moving one of the projection lenses; this motion also is digitized photoelectrically. After setting each point, the measured data are punched on tape, to be fed later to an electronic computer. The design, operation, and performance of the machine are described in some detail, together with the principles of measurement and some proposed improvements. (auth)

6155 AUTOMATIC LIVE-TIME MEASUREMENT AND BACKGROUND SUBTRACTION FOR THE HUTCHINSON-SCARROTT PULSE HEIGHT ANALYZER. K. F. Orton and K. Wilkins (English Electric Co., Ltd., Whetstone, Leics, Eng.). Nuclear Instr. & Methods 9, 97-101(1960) Oct. (In English)

A circuit is described which measures the live-time of the pulse height analyzer, presents this value on a Dekatron display and automatically performs background subtraction for preset periods of live-time. (auth)

6156 PULSE HEIGHT DISCRIMINATOR EMPLOYING DISTRIBUTED AMPLIFICATION. C. Infante (Comitato Nazionale per le Ricerche Nucleari, Frascati, Italy). Nuclear Instr. & Methods 9, 102-6(1960) Oct. (In English)

An integral pulse-height discriminator employing distributed amplification is proposed. The discriminator accepts 0.5 to 12 volts positive input pulses with a maximum repetition rate in excess of 20 mc. Dead time is less than 25 mμsec and threshold uncertainty is 30 mv. The circuit uses 20 vacuum-tubes in an arrangement believed to be new. (auth)

6157 CORRECTIONS FOR BACKSCATTERING AND ENERGY RESOLUTION IN BETA SPECTROSCOPY BY SCINTILLATION DETECTORS. G. Bertolini, F. Cappellani, and A. Rota (Comitato Nazionale per le Ricerche Nucleari, Ispra, Italy). Nuclear Instr. & Methods 9, 107-10(1960) Oct. (In English)

The correction for phosphor backscattering and energy resolution was applied to plastic detectors. The application of the correction terms to the β spectra of Tl^{204} and Tm^{170} gave satisfactory results. (auth)

6158 A DIFFERENTIAL BEAM COLLECTOR. W. T. H. Van Oers (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nuclear Instr. & Methods 9, 111-12(1960) Oct. (In English)

A double faraday cup was built, which can measure the energy of a beam of charged particles by determining their mean range, and which can simultaneously be used to integrate the current of the beam. (auth)

6159 A NEW TYPE OF LIQUID ANODE GAMMA AND BETA HALOGEN COUNTER. S. C. Pancholi (Univ. of Delhi). Nuclear Instr. & Methods 9, 118-19(1960) Oct. (In English)

A new type of radiation counter is described which uses a thin glass tube filled with conducting water as the anode. This type of halogen counter is characterized by a fairly good plateau slope and a large plateau width. The preliminary findings are described. (auth)

6160 PROMPT CRITICAL ASSEMBLY GAMMA RAY SOURCES. Charles S. Shapiro (International Business Machines Corp., Owego, N. Y.). Nuclear Sci. and Eng. 8, 515-17(1960) Dec.

The method of obtaining the γ dose rate during a prompt critical burst from the "Godiva" reactor is presented. In this measurement, the fission-product γ-ray contribution to the total γ-ray dose must be determined. The determination of this quantity is described along with the results. Conclusions are drawn as to the relative contributions to

the total dose from prompt, capture, and inelastic collision γ-ray sources. (auth)

6161 SPECTRAL COMPARISONS WITH HIGH ENERGY ACTIVATION DETECTORS. James Grundl and Arthur Usner (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 598-607(1960) Dec.

The responses of the activation detectors P(n,p), Al(n,p), Fe(n,p), Al(n,α), and Cu(n,2n) to the neutron spectra at the center of the bare U^{235} and Pu^{239} critical assemblies, Godiva and Jezebel, are the basis of a precision comparison of these two spectra above 2 Mev. Results, interpreted in terms of the spectral function $E^{\frac{1}{2}}e^{-\beta E}$, show that the average energy of this component of the spectrum in Godiva is 4.7 ± 0.8% lower than in Jezebel. From some preliminary measurements a close resemblance to the corresponding fission neutron spectra is indicated in this energy region. Results of photoplate measurements in the leakage spectra of both assemblies are considered and analyzed. A discussion and determination of effective thresholds is appended. (auth)

6162 STATISTICAL TESTS FOR COUNTING. Arthur H. Jaffey (Argonne National Lab., Ill.). Nucleonics 18, No. 11, 180-4(1960) Nov.

The distribution of results around the true value according to a distribution function is discussed. The consistency of the data, accuracy of the method, and probable error can be deduced from this distribution function. An expression for estimating error is given. Error propagation, data pooling, reliability and consistency, and determination of constants in linear equations were investigated. Applications of the distribution function in obtaining the maximum accuracy from a counter in the presence of a significant background are discussed. (M.C.G.)

6163 γ-RAY CALIBRATION ENERGIES. Jerry B. Marion (Univ. of Maryland, College Park, Md.). Nucleonics 18, No. 11, 184(1960) Nov.

The γ rays most commonly used for energy calibration in γ spectroscopy are given. Gamma energy and half life are given for 20 sources. In the case of complex decays only the most intense γ rays are given. (M.C.G.)

6164 LOW TEMPERATURE ELECTROMETER CIRCUIT. J. A. Carruthers (McGill Univ., Montreal), D. E. Benyon, and J. Nicholls. Nucleonics 18, No. 12, 84, 86 (1960) Dec.

A modified floating-grid circuit that provides superior subzero performance but retains the simplicity of the conventional floating-grid circuit was developed. The circuit is different in three ways: the anode battery is returned to filament positive, the zeroing resistor is in series with the anode, and the calibration adjustment is in the bucking circuit. Thirty-one CK5886 tubes were used to compare the performance of two circuits when operated for several hours with batteries maintained at −23°F. The average drift corresponded to a log scale error of 15% for the compensated circuit compared with 60% using the conventional circuit. (M.C.G.)

6165 HOW HARWELL MAKES SURFACE-BARRIER DETECTORS. G. Dearnaley and A. B. Whitehead (Atomic Energy Research Establishment, Harwell, Eng.). Nucleonics 19, No. 1, 72; 74-6(1961) Jan.

Methods used in the preparation of gold-silicon and germanium-gold semiconductors are described. Possible improvements in the development methods are discussed. (B.O.G.)

6166 MEASUREMENT OF TIME INTERVALS FOR TIME CORRELATED RADIOACTIVE DECAY. H. Lindeman, E. Mornel, and U. Galil (Israel Inst. of Tech., Haifa, Israel). Physica 26, 961-6(1960) Nov. (In English)

The distribution of time intervals between successive counts was measured for radioactive decay in the thorium series. The measurements showed that the classical Marsden-Barratt law does not apply to this case of time-correlated decay. They appeared, however, to be in agreement with the theory of Lindeman-Rosen, taking into account the fact that the counter receives only the radiation emitted in a solid angle near to 2π. (auth)

6167 USE OF BUBBLE CHAMBERS FOR EXPERIMENTS WITH HIGH ENERGY GAMMA-RAY BEAMS. L. Guerriero, Hans Mark, I. A. Pless, L. Rosenson, Y. Shapira, A. Tuchman, and R. K. Yamamoto (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr. 31, 1040-3(1960) Oct.

Visual particle detection methods were used with high energy bremsstrahlung beams of low intensity. A method for obtaining a substantial increase in the γ-ray beam intensity which can be passed through a 9-in. propane bubble chamber is described. The beam is collimated and led through a hollow tube passing through the middle of the bubble chamber. It was found that use of a "beam tube" increases the number of events observed per picture by a factor between five and ten over the number found with no beam tube. The 300-Mev bremsstrahlung beam of the MIT synchrotron beam was used for the experiments. Advantages and limitations of the beam tube method are discussed. (auth)

6168 TRANSISTORIZED COINCIDENCE CIRCUIT FOR π-e EXPERIMENT. R. H. Miller (Univ. of Chicago). Rev. Sci. Instr. 31, 1047-51(1960) Oct.

A special purpose coincidence circuit with millimicrosecond resolution time is described which illustrates the simplicity that can be achieved with transistorized circuits. The circuit performs all the logical operations of three simultaneous experiments to measure the branching ratio to the electronic mode of pion decay. Performance data under operating conditions on the cyclotron are given. (auth)

6169 THE STILBENE SCINTILLATION CRYSTAL AS A SPECTROMETER FOR CONTINUOUS FAST-NEUTRON SPECTRA. H. W. Broek and C. E. Anderson (Yale Univ., New Haven). Rev. Sci. Instr. 31, 1063-9(1960) Oct.

A method is described for measuring neutron spectra at energies of 1 to 10 Mev. The pulse-height spectrum of scintillations produced in a stilbene crystal by recoil protons originating in the crystal is analyzed to yield the incident neutron energy distribution. Insensitivity to γ rays and electrons is achieved by utilizing differences in the pulse shapes of light pulses produced by electrons and protons. The spectrometer is useful for both group and continuous spectra and has been tested by measurement of the spectra from a Pu-Be neutron source and from the spontaneous fission of Cf^{252}. Both measurements are consistent with previous data. The Pu-Be data definitely confirm a peak at 9.7 Mev that was suggested by previous data. (auth)

6170 PUNCHED TAPE READOUT FOR A MULTICHANNEL PULSE-HEIGHT ANALYZER. Jack Brotzman (U. S. Naval Research Lab., Washington, D. C.). Rev. Sci. Instr. 31, 1073-6(1960) Oct.

An instrument for transferring information from a mag-

netic core memory to punched paper tape is described. When used with a 100-channel pulse height analyzer with a capacity of 10^5 counts per channel, total readout time for all 100 channels is less than 17 sec. (auth)

6171 SMALL GENERAL PURPOSE DOUBLE FOCUSING MASS SPECTROMETER. Alfred O. Nier (Univ. of Minnesota, Minneapolis). Rev. Sci. Instr. 31, 1127-32 (1960) Oct.

A small high performance double focusing mass spectrometer employing a 90° electrostatic analyzer and a 60° magnetic analyzer is described. The radius of curvature of ion paths in the magnetic analyzer is 2 in. As a laboratory instrument for making gas or isotope analyses, its sensitivity and resolution make it competitive with instruments several times as large employing only a magnetic analyzer. With a permanent magnet the weight and power consumption are both low, making it attractive for applications where these factors may be of importance. (auth)

6172 SOME CONSIDERATIONS ON LUMINESCENT FIBER CHAMBERS AND INTENSIFIER SCREENS. L. Reiffel and N. S. Kapany (Armour Research Foundation, Chicago). Rev. Sci. Instr. 31, 1136-42(1960) Oct.

Factors affecting the performance of filamentary scintillators are considered. Experimental data on light attenuation for both plastic scintillator filaments and thin-wall glass tubing liquid scintillators are presented. A theoretical interpretation which satisfactorily accounts for the performance of luminescent filaments in terms of bulk properties and surface reflection losses is given and permits quantitative evaluation of surface losses for various materials. While plastic scintillator fibers are mechanically convenient, it is suggested that liquid-filled fibers will prove more consistent and stable in their properties. Comments on the utility of arrays of fibers as particle track imaging devices and as image intensifier screens are included. (auth)

6173 CROSSED ELECTRIC AND MAGNETIC FIELD MULTICHANNEL ION ANALYZER. L. Evan Bailey (Stanford Research Inst., Menlo Park, Calif.). Rev. Sci. Instr. 31, 1147-52(1960) Oct.

A multichannel mass and energy analyzer using crossed electric and magnetic fields for ion separation was constructed to analyze plasmas produced in conjunction with a magnetic mirror machine. Ions are piped between the strong magnetic field of the mirror machine and the weaker magnetic field of the analyzer by auxiliary magnetic coils, and enter the analyzer traveling in a direction nearly parallel to the magnetic field. The ions are accelerated by the electric field and assume cycloid-like trajectories in the plane perpendicular to the magnetic field. The ions are collected by detectors located at the top of the cycloid. The amplitude of the cycloid is determined by the e/m of the ion; the distance traversed parallel to the magnetic field before collection is proportional to the velocity of the ion. (auth)

6174 EMISSION REGULATOR DESIGNED FOR MASS SPECTROMETER USING A CHOPPER AMPLIFIER. W. Corfield, H. McCullough, and J. Lipson (Univ. of Alberta, Edmonton). Rev. Sci. Instr. 31, 1153-5(1960) Oct.

A regulator was designed for the emission of a Winn-Nier source which is focused on a trap by a control plate voltage. The requirements for high sensitivity and accurate isotope ratio measurements were: (1) regulated trap currents, (2) chopped error signals for use of a-c amplification, (3) constant electron energy with regulation, (4) ease of setup and test, and (5) a system which does not have filament burnout from failure. A schematic of the complete circuit is given. Additional advantages other than those attained from the requirements are described. (B.O.G.)

6175 SCINTILLATOR FOR THERMAL NEUTRONS USING Li^6F AND ZnS(Ag). R. Stedman (Atomic Energy of Canada Ltd., Chalk River, Ont.). Rev. Sci. Instr. 31, 1156 (1960) Oct.

A description is given of the characteristics of a Li^6–ZnS scintillator which has a detection efficiency for a thermal spectrum of neutrons one and one-half times that of the best available scintillator based on B^{10} and ZnS, and almost three times that of commercially available B^{10}–ZnS scintillators. The detection efficiency of the Li^6–ZnS scintillator was determined by comparison with a BF_3 counter in a beam of monokinetic neutrons. The scintillator is insensitive to γ rays, although a counter assembly consisting of a large light guide of Lucite as well as the scintillator and a photomultiplier does respond to γ rays at low bias settings. (B.O.G.)

6176 CALORIMETER AND ACCESSORIES FOR VERY HIGH THERMAL RADIATION FLUX MEASUREMENTS. J. C. Cook (Southwest Research Inst., San Antonio) and H. S. Levine. Rev. Sci. Instr. 31, 1160-1(1960) Oct.

A modification is described for a high radiation-flux absolute water-flow calorimeter which was made to extend its range of usefulness. It was designed specifically for use with a carbon arc-image furnace to measure flux densities at 1200 to 1500 cal/cm^2/sec. The calorimeter system and accessories are shown assembled with the drive system and supporting wheels for the rotating-slit attenuator. The calorimeter and rotating attenuator have performed together and with other components with complete satisfaction at incident thermal fluxes to 600 cal/cm^2/sec. (B.O.G.)

6177 IMPROVED PERFORMANCE FROM SCINTILLATION SPECTROMETERS. D. O. Wells, S. L. Blatt, and I. F. Boekelheide (Stanford Univ., Calif.). Rev. Sci. Instr. 31, 1163-4(1960) Oct.

A method is described which was used to minimize light loss through the glass envelope of the photomultiplier (PM), to obtain a smaller instrumental line width, and to obtain a larger pulse height from a given crystal-PM tube combination in a scintillation spectrometer. Reflective coatings, to reflect toward the photocathode the light which might otherwise escape through the PM-tube edge, were applied around the edges of the face plate and of the optical coupling layer. The results of experiments with Tygon paint and smoked MgO are tabulated. It is noted that the coatings improved the instrumental line width and pulse height in each of the cases. (B.O.G.)

6178 ON THE USE OF 2N504 TRANSISTORS IN THE AVALANCHE MODE FOR NUCLEAR INSTRUMENTATION. Ralph Fullwood (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instr. 31, 1186-9(1960) Nov. (NYO-2811)

Philco 2N501, 2N502, and 2N504 transistors were operated successfully in the avalanche mode as fast discriminators on photomultiplier tubes and as the pulse generating element in pulse generators. They exhibit the property of a fast rise time ($\lesssim$1 nsec) and sharp discriminating characteristics but have the disadvantage of a long recovery time (~80 nsec). (auth)

6179 IMPROVED "TWIN" SCINTILLATION FAST NEUTRON DETECTOR. I. B. Berlman, R. Grismore, and B. G. Oltman (Argonne National Lab., Ill.). Rev. Sci. Instr. 31, 1198-1200(1960) Nov.

Improvements are presented in the use of the "twin" scintillation detector described earlier. Conditions are specified under which the fluorescence yield is maximized and the proton-to-electron ratio equalized in both solutions. For a neutron energy of 2.19 Mev the instrumental line width is 23%. The estimated lower limit of its potential range is $\frac{1}{4}$ to $\frac{1}{3}$ Mev. Other improvements in sensitivity have permitted the measurement of background neutron fluxes of the order of those produced by cosmic rays. (auth)

6180 FAST TRANSISTORIZED TIME-TO-PULSE-HEIGHT CONVERTER. G. Culligan and N. H. Lipman (European Organization for Nuclear Research, Geneva). Rev. Sci. Instr. 31, 1209-14(1960) Nov.

A transistorized time-to-pulse-height converter is described which has a time base range of 0 to 15 nsec, and a stability of 10^{-10} sec. The circuit was used for the mass analysis of particle beams by time-of-flight. Time resolutions of 10^{-9} sec were obtained using conventional scintillation counters. The circuit has a short dead time (3×10^{-7} sec), contains a gating facility, but is of simple design. It has been in use at CERN for 6 months, and functions satisfactorily under experimental conditions. (auth)

6181 THEORY OF A HIGH DISPERSION DOUBLE FOCUSING BETA-RAY SPECTROMETER. H. Daniel and L. Jackson Laslett (Ames Lab., Ames, Iowa). Rev. Sci. Instr. 31, 1225-8(1960) Nov.

A "flat" high-dispersion double-focusing β spectrometer is proposed, and results of computations are presented. The high dispersion is achieved by making the electrons orbit around the field axis more than once. The source and detector are displaced radially, in opposite directions, from the stationary circular orbit. A suitable baffle is mounted between the source and detector to shield the detector against unwanted electrons. The electron-optical properties are almost the same as for the $\pi\sqrt{2}$ spectrometer except that the dispersion is increased. Numerical results are presented for two instruments with focusing angles of 565.88 and 909.02°, with respective dispersions of 21.5 and 50.6, to be compared with a dispersion of 4 for the $\pi\sqrt{2}$ spectrometer. (auth)

6182 TRANSMISSION OPTICS OF FOCUSED ION BEAMS USED IN MASS SPECTROMETRY. Leonard A. Dietz (Knolls Atomic Power Lab., Schenectady, N. Y.). Rev. Sci. Instr. 31, 1229-33(1960) Nov.

Current density profiles and angular spreading of low intensity positive ion beams are measured with scanning slits in an evacuated beam analyzer. Experimental measurements are made of spherical aberration and transverse thermal velocity at a crossover focused by an ion gun. Spherical aberration is determined by an extrapolation technique which apparently has not been used before. Beam constants were evaluated for an ion gun used with V type, flat ribbon, and multiple filaments. Each type of surface ionization filament produces a beam of elliptical cross section. Expressions are given for the variations of current density in a plane normal to and moved along the beam axis in field-free image space, and for the beam fraction transmitted through a rectangular aperture. Application of the results to estimate the degree of voltage and mass discriminations is discussed. (auth)

6183 TRANSISTORIZED RATEMETER DESIGN. James F. Marvin, William D. Miller, and Merle K. Loken (Univ. of Minnesota Hospitals, Minneapolis). Rev. Sci. Instr. 31, 1238-40(1960) Nov.

Extensively increasing adaptation and use of radioactive isotopes for in vivo studies of the circulatory system has dictated improvement in the electronic instrumentation necessary to detect and measure progress of the isotope through the system. Inasmuch as the time intervals of circulatory studies are rather short (not over 30 sec), speaking on a gross scale, measurements at several different checkpoints must be accomplished with duplicate immobilized detectors rather than a single movable unit. A transistorized ratemeter featuring lower power requirements, smaller space consumption, superior reliability, and durability together with the stability of vacuum tube circuits in alternating-current operation was developed to make practicable multiple channel in vivo counting systems for use in the modern x-ray or operating room. (auth)

6184 NEAREST COUNT INDICATION IN COUNTER TIMERS AND RELATED ANALOG-DIGITAL CONVERTERS. R. Stuart Mackay (Univ. of California Medical Center, San Francisco). Rev. Sci. Instr. 31, 1241-2(1960) Nov.

A method for measuring time intervals is to count the cycles arriving from a constant frequency source during the interval. A method is outlined using a pulsed oscillator to reduce the uncertainty in the measurements. The pulsed oscillator is desirable since oscillation always starts upward from zero at the start of the interval and thus removes the starting uncertainty. An alternative way of avoiding starting in a random phase is to begin with a high frequency continuous oscillator and divide the frequency to the desired one with a monostable relaxation circuit synchronized by an input frequency of period short with respect to the duration of the abnormal state. The ways in which these concepts may improve some analog-to-digital converters are discussed. (B.O.G.)

6185 LARGE RECORDING POTENTIOMETER ERRORS CAUSED BY FURNACE LEAKAGE CURRENTS. William Primak and Edward Edwards (Argonne National Lab., Ill.). Rev. Sci. Instr. 31, 1242(1960) Nov.

Large errors in the readings of recording and recording-controlling potentiometers used with furnace thermocouples have been noted to be affected from ~600°C upward. An investigation showed that the 10% errors at 1000°C were a result of electrical conduction through the ceramic furnace walls and the fused quartz thermocouple sheath. The temperature dependence of the effect corresponded to the temperature dependence of the electrical resistivity of silica. It is evident that ceramics, as customarily employed, are not adequate for insulating thermocouples from furnace windings at high temperatures. Alternative solutions adequate to the present applications are (1) to suspend the thermocouple out of contact with the furnace walls which are at high temperatures, and (2) to provide a grounded metallic sheath between the furnace wall and the ceramic thermocouple sheath. (B.O.G.)

6186 STRETCHER FOR SHORT COUNTER PULSES. W. F. Cummins and D. R. Branum (Univ. of California, Livermore). Rev. Sci. Instr. 31, 1247-8(1960) Nov.

A pulse stretcher circuit is described which was used to display short pulses from a plastic recoil counter on an oscilloscope sweeping at a relatively slow speed. The design requires that the stretcher generate a relatively flat-topped pulse and need no external power supply. The

maximum stretched pulse level is of the order of 6 volts, which is established by the maximum collector-base voltage in the transistor. The minimum level is 30 to 40 mv and is determined by noise from delay-line reflections and various distributed reactances. Patterns are included showing stretched Co^{60} pulses. (B.O.G.)

6187 NEW THERMOLUMINESCENT DOSIMETER. James H. Schulman, Frank H. Attix, Edward J. West, and Robert J. Ginther (Naval Research Lab., Washington, D. C.). Rev. Sci. Instr. 31, 1263-9(1960) Dec.

A dosimeter design is described in which a thermoluminescent phosphor is mounted on an electrically heatable support in an evacuated or gas-filled envelope. With CaF_2:Mn as the phosphor, the device detects γ doses in the milliroentgen range and has linear response to 2×10^5 r. Dose readings can be made in less than a minute with simple instrumentation requiring no darkroom facilities. The dosimeter may be reused many times. The response is independent of dose rate for at least 10 mr/min to 7000 r/min. With suitable tin shields the response is independent of energy at 40 kev to 1.25 Mev. The advantages of this device for personnel monitoring in health physics operations are pointed out. (auth)

6188 DESIGN OF MUTUAL INDUCTANCE BRIDGE FOR CRYOGENIC MEASUREMENTS. L. D. Jennings (Ames Lab., Ames, Iowa). Rev. Sci. Instr. 31, 1269-74 (1960) Dec. (IS-32)

It is shown that a mutual inductance bridge may be designed whose components are small and which allows a magnet to be placed around the unknown with no less in sensitivity and accuracy. An instrument that embodies these principles is described, and techniques are given for obtaining accurate and rapid measurements of the real and imaginary components of the unknown. (auth)

6189 NaI(Tl) SUMMING COMPTON SPECTROMETER. H. Takekoshi (Japan Atomic Research Inst., Tokyo). Rev. Sci. Instr. 31, 1280-5(1960) Dec.

A method of measuring γ-ray energy by using two sodium iodide crystals is described. The sum of two pulses is to be taken: one from a crystal that scatters γ rays by the Compton effect and the other from a second crystal that receives the scattered photon. In comparison with the scintillation Compton spectrometer hitherto developed, this method is good both in efficiency and in resolution. (auth)

6190 ACCUMULATING DIGITIZER SYSTEM. Thomas H. Fields and Robert W. Findley (Carnegie Inst. of Tech., Pittsburgh). Rev. Sci. Instr. 31, 1312-17(1960) Dec.

A system is described for digital measurement and automatic recording of linear or angular position. An adding-subtracting scaler is used to accumulate pulses generated by the digitizing element. Several of the major components are commercially available. The performance of the system as used for coordinate measurements on bubble-chamber photographs is discussed. (auth)

6191 DEVICE FOR GENERATING A LOW TEMPERATURE, HIGHLY IONIZED CESIUM PLASMA. Nathan Rynn and Nicola D'Angelo (Princeton Univ., N. J.). Rev. Sci. Instr. 31, 1326-33(1960) Dec. (MATT-45)

A device for generating a linear, highly-ionized low-temperature cesium plasma is described. The plasma is generated by having the output of cesium atomic beam ovens impinge on hot tungsten plates placed at both ends of a cylindrical vacuum chamber. The walls of the chamber are cooled so that neutral cesium condenses on them. The theory of the device, designated as the Q machine, is presented; and some experimental results are given. The maximum density achieved was $2 \times 10^{12}/cm^3$, with an estimated fractional ionization of 99% and a confining field of 5900 gauss. (auth)

6192 A DEFORMATION CALORIMETER. Robin O. Williams (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr. 31, 1336-41(1960) Dec.

A calorimeter was constructed which adiabatically deforms metals with a known mechanical energy. The energy that is stored in the sample as a result of the deformation is the difference between the supplied energy and the heat that is found by the increase in sample temperature. It is possible to follow subsequent energy releases that take place immediately following the deformation; for some materials, this release can be an appreciable fraction of the stored energy. The results for the stored energy are considered to be accurate to approximately 10%. (auth)

6193 TOTAL ABSORPTION GAMMA-RAY SPECTROMETERS UTILIZING ANTICOINCIDENCE SHIELDING. R. W. Perkins, J. M. Nielsen, and R. N. Diebel (General Electric Co., Richland, Wash.). Rev. Sci. Instr. 31, 1344-9 (1960) Dec.

Two total absorption γ-ray spectrometers utilizing anticoincidence shielding are described. One of these consists of a 5-in. diameter by 5-in. thick NaI(Tl) well crystal enclosed in a 26-in. diameter by 30-in. high plastic phosphor. The phosphor serves as the anticoincidence guard. The second spectrometer consists of a 3-in. diameter by 3-in. thick NaI(Tl) crystal with a $9\frac{3}{8}$-in. diameter by $8\frac{1}{2}$-in. thick NaI(Tl) well crystal as its anticoincidence guard. With the anticoincidence shielding and a point source in the well of the 5×5-in. crystal, the Compton portion of the Zn^{65} spectrum is reduced by a factor of about 5, whereas the Compton portion of the Co^{60} spectrum (below 1 Mev) is reduced by factors of 20 to 25. With these point sources on top of the 3×3-in. solid crystal, Compton regions are reduced by factors of about 4 and 14, respectively. The anticoincidence shielding arrangements provide background reductions of a factor of 2 to 5 below 3 Mev. The response of the spectrometers to other γ energies is included. The photomultiplier mounting arrangements for the large NaI(Tl) and plastic phosphors and the resolutions of the plastic and NaI(Tl) crystal are discussed. (auth)

6194 ACHIEVEMENT OF EXTREMELY HOMOGENEOUS MAGNETIC FIELDS. L. S. Goodman (Argonne National Lab., Ill.). Rev. Sci. Instr. 31, 1351-2(1960) Dec.

A design is given of a magnet for producing a uniform homogeneous field. The pole piece assembly consists of two Hypernom pole pieces separated by quartz spacers with a nonmagnetic gap of quartz to separate the pole assembly from the Armco iron legs. The sharpening of the atom-beam resonance in Ga^{72} as a result of magnetic circuit modifications is given, comparing old pole pieces and the new pole design. (B.O.G.)

6195 VIEWING PROBE FOR HIGH VOLTAGE PULSES. Walter LeCroy and Jerome Rosen (Columbia Univ., New York). Rev. Sci. Instr. 31, 1354(1960) Dec.

A probe was designed for viewing beam deflection pulses of ~50 kv amplitude and ~0.1 μsec in pulsed-beam studies. The design required that it withstand the voltages involved and provide large attenuation to yield a convenient output

amplitude. The geometry and electrical circuit of the probe are illustrated. (B.O.G.)

6196 SAMPLE ASSEMBLY FOR NEUTRON DIFFRACTION STUDIES OF LIQUEFIED GASES. Glen T. Clayton and LeRoy Heaton (Argonne National Lab., Ill.). Rev. Sci. Instr. 31, 1355-6(1960) Dec.

A single crystal of aluminum was used to fabricate a sample assembly in which neutron-diffraction studies could be made on liquefied gases. The design requirements were as follows: the sample cell must have the ability to withstand pressures of 100 atm while producing no intense diffraction pattern, and it must be hermetically sealed, a good thermal conductor, and fairly transparent to thermal neutrons. A diagram is given of the sample assembly. With proper orientation, patterns obtained using the cell compare favorably with patterns from empty cells fabricated from thin polycrystalline aluminum or vanadium. (B.O.G.)

6197 TRANSISTORIZED BLOCKING OSCILLATOR DISCRIMINATOR AND COINCIDENCE CIRCUIT. M. Feldman (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instr. 31, 1356-7(1960) Dec.

A blocking oscillator is described that has been used as the discriminator of a 16-nsec resolving time coincidence circuit. It produces 2-v pulses into a 100-ohm load and has a sharp, stable threshold. The time jitter for marginal pulses is ~7 nsec. The dead time is ~25 nsec. Circuit diagrams are given for both the blocking oscillator and the coincidence circuit. (B.O.G.)

6198 GROUNDING OF BETA SOURCES BY AN AUXILIARY ALPHA SOURCE. R. T. Nichols and E. N. Jensen (Ames Lab., Ames, Iowa). Rev. Sci. Instr. 31, 1358(1960) Dec. (IS-183)

A Po^{210} source was used to furnish a reliable ground for both electron and positron sources. This was done to prevent the electron and positron sources from charging during β spectral studies in magnetic lens spectrometers. An ~20-μc Po^{210} source was placed 1.2 in. behind a 4-μc Na^{22} positron emitter backed by 20-$\mu g/cm^2$ Formvar in the spectrometer; this arrangement resulted in a charging rate decrease of ~80%. When the source was placed 0.5 in. away, no charging was detectable over a period of more than one week. The discharge is attributed mainly to the loss of electrons from the source and backing caused by ionization of α particles since few α particles are stopped near the source. (B.O.G.)

6199 QUANTOMETER FOR MEASURE OF BREMSSTRAHLUNG ENERGY STREAM FROM BETATRONS AND SYNCHROTRONS AND ITS INVESTIGATION FOR $E_{\gamma\ max}$ < 100 Mev. A. P. Komar and S. P. Kruglov (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Zhur. Tekh. Fiz. 30, 1369-80(1960) Nov. (In Russian)

Quantometer theory was analyzed and theoretical and experimental values for the constant of a quantometer filled with argon or air are correlated. It was found that the quantometer constant does not change at $E_{\gamma\ max}$ from 53 to 85 Mev and is in good agreement with the value for $E_{\gamma\ max}$ = 300 Mev determined by Wilson. (tr-auth)

6200 IMPROVEMENTS IN OR RELATING TO RADIATION MEASURING EQUIPMENT. James Finston Hogg and David Robinson Cockbaine (to United Kingdom Atomic Energy Authority). British Patent 853,175. Nov. 2, 1960.

Radiation measuring equipment utilizing an ionization chamber in conjunction with a fail-safe d-c amplifier described by Cox and Gillespie is designed in which a small a-c voltage of period small compared with the response time of the amplifier is applied to the chamber. The a-c output from the amplifier is used to operate a fault-indication circuit. A circuit diagram is included. (D.L.C.)

6201 A RADIATION DOSAGE INDICATOR. (to General Aniline & Film Corp.). British Patent 854,897. Nov. 23, 1960.

A radiation dosage indicator for megaroentgen dosimetry is designed comprising (1) a sheet of photographic high-speed print-out paper which undergoes a color change upon being irradiated, (2) a perforated color comparison member with areas of different color overlaying the print-out paper, and (3) a sheet of light filter material (such as Wratten No. 22) to protect the assembly from light. The assembly is mounted on adhesive tape so that it can be used like a label for radiation monitoring. (D.L.C.)

Materials Testing

6202 (NAA-SR-Memo-5261) AN APPARATUS FOR OBSERVING CRACKING AND CREEP IN ZIRCONIUM ALLOY SPECIMENS WHEN IMMERSED IN MOLTEN Na OR NaK. D. M. Lonneaux (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 6, 1960. 4p. OTS.

A study was made of vessel designs to test zirconium alloy specimens under tensile stresses sufficient to produce 2% elongations while immersed in molten alkali metals and to externally measure the creep of the specimens. (W.L.H.)

6203 (SCTM-376-60(71)) INSULATION-RESISTANCE AND HIGH-POTENTIAL TESTING GUIDE FOR THE DESIGN ENGINEER. R. E. Knutson (Sandia Corp., Albuquerque, N. Mex.). Dec. 1960. 9p. OTS.

Guidance is provided for the design engineers who must specify electrical insulation tests. An attempt is made to establish consistent and meaningful insulation-resistance and high-potential testing procedures. (auth)

6204 NEW X-RAY TECHNIQUE LOCATES CORE IN FUEL PLATES. Charles A. Ziegler, J. C. McCue, J. Brinkerhoff, and D. Chleck (Tracerlab Inc., Waltham, Mass.). Nucleonics 19, No. 1, 76-8(1961) Jan.

A technique that uses coherent x-ray scattering is described which provides a quick production-line method for efficiently and accurately locating the uranium sandwiched in clad reactor fuel plates. The detector system includes collimator, crystal, phototube, and pulse-height analyzer with high integral bias. It was found that an x-ray spectrum peak at 90 kev gave the best balance between count rate and discrimination. Data for two scans parallel to the longitudinal axis of the plate and at two different distances are given graphically showing the taper of the fuel at the end of the core. The results of the tests were checked by the manufacturer by precise destructive measurements; the agreement of both test methods averaged 0.007 in. If destructive test results are accepted as a standard, the accuracy of the x-ray method is greater than the present manufacturer specification of ±0.015 in. (B.O.G.)

6205 PROGRESS IN NON-DESTRUCTIVE TESTING. VOLUME 2. E. G. Stanford and J. H. Fearon, eds. New York, The Macmillan Company, 1960. 254p. $12.00.

The second of a series of volumes containing critical reviews of special aspects of nondestructive materials testing, presents seven papers, of which two are abstracted.

The papers deal with the uses of high-energy x rays, electric resistance, radioisotopes, ultrasonic waves, inelastic damping of stress effects, and paramagnetic resonance. (D.L.C.)

6206 RADIOLOGY WITH HIGH-ENERGY X-RAYS. R. Halmshaw and C. G. Pollitt (Armament Research and Development Establishment, Fort Halstead, Kent, Eng.). p.1-26 of "Progress in Non-Destructive Testing. Volume 2."

The possible use of high-energy x rays to penetrate thick metal specimens for nondestructive testing is reviewed. A brief description of commercially available equipment for megavoltage radiography is given, and available data on the peak energy, beam width, output, scattered radiation effects, and image sharpness and definition are discussed. Some special points in megavoltage radiography applications are considered. Wire penetrameter sensitivity data are tabulated and plotted vs. steel plate thickness for x rays of varying energy. Stereo-radiography (determination of defect depth), flash and stroboscopic radiography (using sharply pulsed x rays), and neutron radiography (neutrons produced by x rays) are discussed. An outline is given of the type of work presently being performed with the aid of megavoltage radiography. 87 references. (D.L.C.)

6207 THE USES OF RADIOACTIVE ISOTOPES IN NON-DESTRUCTIVE TESTING. J. F. Cameron (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.91-164 of "Progress in Non-Destructive Testing. Volume 2."

An extensive review is presented on radioisotope applications in nondestructive testing, especially in thickness measurement. Among the items treated are interaction of radiation with matter; radiation detectors; thickness gage design; tracer applications in velocity measurement, air renewal and filter testing, flow pattern determination, mixing efficiency, go-devil location, crack and leak detection, and wear measurement; use of radioisotopes in chemical analysis; and safety considerations in radioisotope use. (D.L.C.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

6208 (K-1462) VARIATIONS IN THE URANIUM-235 CONTENT OF FIFTEEN ORES. L. A. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 19, 1961. 5p. Contract W-7405-eng-26.

The uranium isotope compositions of samples from 15 ores were compared to a standard. Variations of about 0.1% of the U^{235} content were observed. (auth)

6209 (UCRL-9208(p.12-26)) FURTHER INVESTIGATION OF ORGANIC MATTER IN METEORITE MURRAY. Susan V. Himes (California. Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from an examination, by various methods, of the water extract of meteorite Murray. Results do not preclude the possibility that a pyrimidine is present, but they do indicate that something else must also be present. The ultraviolet spectra of compounds that might possibly be related to the unknown were examined for any resemblance. (C.H.)

6210 (AEC-tr-4208(p.34-41)) A TECHNIQUE FOR THE DETERMINATION OF THORON IN GROUND AIR. V. V. Cherdyntsev. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 34-40(1957).

Two methods are reported for the determination of thoron in ground air. The first method is based on the determination of the decay products. The second method is based on the direct determination of airborne thoron. Both methods are discussed in detail. (W.L.H.)

6211 (AEC-tr-4208(p.42-56)) ON THE CONDITIONS OF FORMATION OF NATURAL RADIUM-BEARING WATERS. E. S. Shchepot'eva. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 41-54(1957).

Research is reported in connection with the processes of adsorption of radioelements by rocks and their leaching under conditions similar to those encountered in nature. (W.L.H.)

6212 (AEC-tr-4208(p.66-90)) THE MIGRATION OF HELIUM FROM MINERALS AND ROCKS. E. K. Gerling. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 64-87(1957).

The amount of helium lost by minerals is a function of their structural characteristics. Minerals with unstable crystalline structures are not in a position to retain the helium that forms in them as a result of radioactive decay; therefore, the quantity of helium that they lose is very large. The quantity of helium lost by the minerals decreases with increasingly dense crystal packing of the crystals. Minerals with maximum crystal packing and without cleavage were found suitable for age determination by the helium method. Experimental data indicate that the rocks studied were unsuitable for age determination by the helium method in view of the escape of a large part of the helium that formed in them. (W.L.H.)

6213 (AEC-tr-4208(p.108-23)) THE LEACHABILITY OF ThX AND RdTh FROM MINERALS. I. E. Starik and N. I. Polevaya. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 104-18(1957).

It was established by experiments set up to study the leachability of radioelements from minerals that the isotopes of thorium and radium behave differently; this is accounted for by their different positions in the crystal lattice. It was established that a certain number of radiothorium atoms are present in the capillaries and are leached out like ThX in spite of the similarity of their ionic radii to that of their parent element thorium. It was found that the isotopes of radium and the emanations behave differently; this is an effect of the different adsorption capacities of these elements. The dependence of the leachability of ThX from minerals on time was established. (W.L.H.)

6214 (AEC-tr-4208(p.146-75)) DETERMINING THE AGE OF MINERALS FOUND IN THE ILMEN MOUNTAINS ON THE BASIS OF RADIOACTIVITY DATA. M. E. Vladimirova. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 139-66(1957).

The ages of the minerals in the Ilmen mountains were determined by the lead and helium methods. The minerals tested were samarskite, eschynite, allanite, and chevkinite. (W.L.H.)

6215 (AEC-tr-4269) EXCESS U^{235} IN MAGNETITE WITH A HIGH CONTENT OF ACTINIUM. (Izbytok U^{235} v Magnetite s Povyshennym Soderzhaniem Aktiniya). V. V. Cherdyntsev, E. A. Isabaev, Yu. A. Surkov, D. P. Orlov, and E. P. Usatov. Translated from Geokhimiya, 373-4 (1960). 5p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 19205.

6216 (CEA-tr-R-1012) RAPPORT ISOTOPIQUE $^{234}U/^{238}U$ DANS CERTAINS MINÉRAUX SECONDAIRES. (Isotopic Ratio U^{234}/U^{238} in Certain Secondary Minerals). P. I. Chalov. Translated into French from Geokhimiya 2, 165-70(1959). 13p.

The U^{234}/U^{238} ratio was measured in samples of secondary minerals. The results confirm the observation that enrichment of U^{234} and depletion of U^{234} both take place in natural formations. The U^{234} is leached. It is irrefutable that the principle role, though, is played by recoils, the U^{234} being weakly or not at all bound to the crystal lattice of the mineral. However, in minerals in which the uranium is in the tetravalent state, oxidation plays an equally important part since a free isotope would be more easily oxidized to the hexavalent state in which it is freely transported by natural solutions. (T.R.H.)

6217 (UCRL-Trans-513(L)) INVESTIGATION OF ATMOSPHERICS IN ITALY. Piero Ilardi. Translated by Mary Kilpatrick from Meteorol. pract. 19, 195-7 (1938). 4p. JCL.

The Italian Radioatmospheric Service, since its establishment in 1928, has used the auricular method for observations of the intensity and frequency of atmospherics. A conventional scale was established following patient experiments. Data have been cumulated from the collaborations of many observatories geographically distributed throughout Italy. The methods used in the observations are described. Results of the studies indicate that the frequency of atmospheric disturbances depends on the over-all global level and the local barometric pressure. (C.H.)

6218 ISOTOPE COMPOSITION OF URANIUM FROM RARE-EARTH MINERALS. Yu. A. Surkov, A. A. Vorob'ev, V. A. Korolev, and V. D. Vilenskiĭ. Atomnaya Energ. 9, 477-82(1960) Dec. (In Russian)

The isotopic composition of rare-earth uranium minerals (orthite, xenotime, and gadolinite) was determined with an ionization chamber and multichannel pulse analyzer in order to determine the possible existence of Cm^{247}. The results are discussed. A method is described for evaluating the α-particle spectrum distortion in an ionization chamber. It is shown that the relative content of U^{235}/U^{238} in low content specimens (0.1 to 1 mg uranium) can be measured with an α spectrometer to an order of error of ~1%. (tr-auth)

6219 ISOTOPIC COMPOSITION OF RUTHENIUM. K. G. Ordzhonikidze and O. S. Akirtava. Atomnaya Energ. 9, 501-3(1960) Dec. (In Russian)

Experiments were carried out with an industrial type mass spectrometer (MC-3). A ruthenium ion emission of 10^{-14} amp was observed for Ru^{102} at ~1950°C. The distribution of ruthenium isotopes with currents of 10^{-12} to 10^{-11} amp were measured in the range 2000 to 2250°C. The data indicate a statistical order of error of 0.06 to 0.15% for all isotopes except Ru^{98} for which the order of error is a little higher. The data are in good agreement with published data. (R.V.J.)

6220 MEASUREMENT OF THE ABSOLUTE CONCENTRATION OF THORON IN THE AIR OF INDUSTRIAL BUILDINGS. Yu. N. Burmistenko. Atomnaya Energ. 9, 505-6(1960) Dec. (In Russian)

Concentrations of thoron ($T_{1/2}$ = 54.5 sec) were measured in an air stream. The current produced by thoron in an ionization chamber is a function of the flow rate of the air passing through the chamber. The concentration of thoron was determined as the difference between the current measured during air passage and the current measured after compensating for air current and thoron decay in the chamber (I_1), $I_{Tn} = I_0 - I_1$. Five to six min was necessary for complete thoron decay. (R.V.J.)

6221 URANIUM TRACE CONTENT OF WATERS DERIVING FROM THE TOKAJ MOUNTAINS AND THEIR FORELANDS. Sandor Szalay and Emil Scherf. Magyar Tudományos Akad. Atommag Kutató Intézete (Debrecen), Közlemenyek 2, 71-98(1960). (In Hungarian)

A geochemical study was made of the uranium content of 341 natural water samples collected in the Tokaj Mountains and their western and southern forelands. The investigations were supplemented with on-the-spot determinations of pH, electric conductivity, and temperature. Mathematical-statistical evaluation of the data was carried out in several groups according to the native rock: rhiolite tuff, all eruptives (including rhiolite tuff), Sarmatian sediment, waters of Holocene and Pleistocene, and Pannonian sediments. In every group the logarithm of uranium concentration showed nearly Gaussian distribution. The uranium contents released from soil dispersions were proportional to the internal surface of the native rock, which can be calculated according to Grassberger. It was concluded that the rare occurrence of uranium enrichments of about 10 γ per liter encountered in some waters of the prospected area is not due to the presence of an enrichment of uranium ore. They rather can be regarded as higher uranium background values corresponding to the finer granulation of native rock. (auth)

6222 CALCULATIONS BY BRUNS-SERIES FOR THE STATISTICAL EVALUATION OF URANIUM TRACES OCCURRING IN NATURAL WATERS. György Meszéna. Magyar Tudományos Akad. Atommag Kutató Intézete (Debrecen), Közlemenyek 2, 99-107(1960). (In Hugarian)

On the basis of a previous report by Szalay and Scherf on uranium content of surface waters, the Bruns-series of two masses of data and characteristic distribution were formed. The relation of distributions corrected by the original Bruns-series to the normal distribution was studied by means of the χ^2-procedure. (auth)

6223 MATHEMATICAL-STATISTICAL STUDIES OF THE PHYSICAL CONDITIONS FOR URANIUM ENRICHMENT OF NATURAL WATERS. Emil Scherf and György Meszéna. Magyar Tudományos Akad. Atommag Kutató Intézete (Debrecen), Közlemények 2, 109-43(1960). (In Hungarian)

Experience reveals a close relation between the uranium concentration of waters permeating the soil and the active internal surface [m^2/m^3] produced by the granulation of the substance under study. The numerical investigation of these relations, as well as the further refinement of the concept of "uranium-background" and references to related literature are given. (auth)

6224 LABORATORY INVESTIGATIONS ON THE PRE-ENRICHMENT OF URANIUM IN COAL ASHES. Sándor Szalay and István Angeli. Magyar Tudomáyos Akad. Atommag Kutató Intézete (Debrecen), Közlemenyek 2, 145-54(1960). (In Hungarian)

The uranium concentration of coals containing uranium was investigated in order to find out by what physical means it could be increased before the more costly chem-

ical recovery is undertaken. Good results, about 2 to 3 times enrichment, were obtained by the classification of coal fractions with different activities. The magnetic separation, however, of the fly-ash of powdered coal was also used. Nevertheless, the application of these methods of preenrichment do not seem at the present to be profitable on an industrial scale. (auth)

6225 INVESTIGATIONS OF URANIUM ADSORPTION TO PEAT IN NATURAL WATERS CONTAINING U-TRACES. Éva D. Horváth. Magyar Tudományos Akad. Atommag Kutató Intézete (Debrecen), Közlemények 2, 177-83(1960). (In Hungarian)

Adsorption tests were made with previously standardized peat samples in well waters of the vicinity of Debrecen, Komádi, and the Taktaköz region. The investigations revealed an average value of 2 to 3, 5×10^2 for the equilibrium constant, the so-called "enrichment factor" of uranium adsorption by peat. (auth)

6226 LABORATORY EVALUATIONS OF NINE WATER TRACERS. R. J. Heemstra, J. Wade Watkins, and F. E. Armstrong (Bartlesville Petroleum Research Center, Okla.). Nucleonics 19, No. 1, 92; 94-6(1961) Jan.

Evaluations were made of nine radioisotopes used as tracers to determine the subsurface flow of water in petroleum reservoirs. The isotopes evaluated were H^3, I^{131}, Rb^{86}, Ir^{192}, Cr^{51}, Sb^{124}, In^{114}, Co^{60}, and Ce^{144}. Two principal requirements for such tracers are low loss through contact with solid petroleum-reservoir materials and stability in brine solutions. Tests were made by passing solutions through geological cores and measuring the activities of the solution after passage through the core and of the drained core materials. The results show that three of the tracers tested should be useful water tracers: tritiated water, I^{131}, as the iodide ion, and Sb^{124} complexed with EDTA. (B.O.G.)

6227 ISOTOPIC COMPOSITION OF SILVER IN AN IRON METEORITE. V. Rama Murthy (Univ. of California, La Jolla). Phys. Rev. Letters 5, 539-41(1960) Dec. 15.

The isotopic composition of silver in the troilite of the Toluca iron meteorite was determined mass spectrometrically and the Ag^{107}/Ag^{109} ratio found to be 1.097 ± 0.002, corresponding to a Ag^{107} enrichment of ~2% relative to terrestrial silver. The excess Ag^{107} result is discussed in terms of Pd^{107} decay, and the time interval between the end of nucleosynthesis and the iron meteorite formation is calculated with the "sudden synthesis" model. (D.L.C.)

6228 ATMOSPHERIC TRANSPORT OF ARTIFICIAL RADIOACTIVITY. E. A. Martell and P. J. Drevinsky (Geophysics Research Directorate, Bedford, Mass.). Science 132, 1523-31(1960) Nov. 25.

The principal shortcoming common to previous attempts to interpret the atmospheric behavior of fall-out is the failure to distinguish the influence of latitude, altitude, and time of injection on the storage time and fall-out pattern for stratospheric sources. On the basis of evidence provided by fission-product concentration ratios in precipitation, Martell pointed out that the short-lived radioisotopes in world-wide fall-out were principally of stratospheric origin and that stratospheric storage times decrease markedly with latitude and increase with altitude. Use was made of 12.8-d Ba^{140}, 53-d Sr^{89}, 28-y Sr^{90}, and 74-d W^{185} concentrations in individual precipitation samples in interpreting some major features of transport and deposition patterns for stratospheric fall-out. The usefulness of fission-product ratio data for estimating the relative contribution of various nuclear-test sources to total fall-out has been questioned on the basis of possibly serious physical and chemical fractionation effects and uncertainties in fission-product production-yield ratios. The chemical similarity of barium and strontium limits chemical fractionation effects on Ba^{140}/Sr^{90} ratio data; Sr^{89}/Sr^{90} ratio data obviously are unaffected by chemical factors. Uncertainties due to the use of production-ratio values, or due to the assumption that there are no fractionation effects, do not seriously affect the usefulness of isotope-ratio data for distinguishing major differences in atmospheric behavior of nuclear-cloud sources of different altitude and latitude for well-spaced nuclear tests. The U. S. Hardtack nuclear-test series provided a useful tracer in W^{185} for studying the behavior of fall-out debris from equatorial tests. Data are given for Ba^{140}/Sr^{90} and Sr^{89}/Sr^{90} ratios and for Sr^{90} and W^{185} concentrations in rainfall for various time periods. (B.O.G.)

HEALTH AND SAFETY

6229 (A/AC.82/G/L.349) MEASUREMENTS OF THE AMOUNT OF RADIOACTIVE FALL-OUT IN FINLAND. Apr. 8, 1960. 5p.

Data are tabulated on radioactivity from fall-out in air and water samples and powdered milk samples collected throughout Finland during 1958 and 1959. (C.H.)

6230 (A/AC.82/G/L.448) STRONTIUM-90 IN HUMAN BONE (RESULTS FROM DENMARK FOR JUNE 1958 TO JUNE 1960). (Le Strontium-90 dans les os Humains (Résultats Recueillis au Danemark de Juin 1958 a Juin 1960). Hilde Levi, J. Lindemann, and A. Nielsen ([Copenhagen. Universitet]) Sept. 2, 1960. 5p.

Results are reported from Sr^{90} determinations on columns of human fetuses, stillborn, and a few children between June 1958 and June 1960. About 40 analyses are reported. The Sr^{90} content varied between 1.5 and 3 s.u. There is no significant trend as a function of time or fetus weight. (T.R.H.)

6231 (A/AC.82/G/L.477) ANNUAL AND GEOGRAPHICAL CHANGE OF Sr^{90} DIETARY INTAKE OF JAPANESE, DURING 1957–1960. Yoshio Hiyama, comp. (Tokyo Univ. School of Agriculture). Aug. 1960. 20p.

Data are tabulated on the Sr^{90} content of the foods making up the average diet in Japan during 1957 to 1960. Sampling methods are discussed. Results are compared with data on the amounts of Sr^{90} deposited in fall-out and rain water during the same period. (C.H.)

6232 (A/AC.82/G/L.478) Sr^{90} IN HUMAN BONE IN JAPAN, DURING 1954-1960. Yoshio Hiyama, comp. (Tokyo Univ. School of Agriculture). Aug. 1960. 11p.

Data are tabulated on the level of Sr^{90} in Japanese human bones during years 1954 to 1960. All the reliable data were collected from various laboratories and classified according to age group and sampling year. Standard methods of analysis were employed. The exact date on sampling and analysis and the part of the skeleton where the bone was taken are omitted, but this information is available in the original reports listed. (auth)

6233 (A/AC.82/G/R.204) TOWARDS AN ASSESSMENT OF THE HAZARD FROM RADIOACTIVE FALL-OUT. A. V. Lebedinskiĭ (Lebedinsky) (U.S.S.R. Nauchnyi-Komitet po Meditsinskoĭ Radiologii, Moscow). 1958. 32p.

The hazards to world populations associated with the

contamination of the earth's surface with long-lived radioactive substances are considered. Emphasis is placed on genetic hazards from Sr^{90} contamination. (C.H.)

6234 (AHSB(S)R-10) RADIATION DOSE RATES FOR PLUTONIUM ISOTOPES. I. Birchall (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). May 20, 1960. 28p. BIS.

Calculations have been made of the expected dose rates arising from the plutonium isotopes and their daughter products resulting from irradiation at 1000 Mwd/tonne and 3000 Mwd/tonne. The results have been extended to include α-n reactions, oxide fuels, and a range of possible fission-product contents. (auth)

6235 (ARF-1158-12) RADIATION STREAMING IN SHELTER ENTRANCEWAYS. Final Report. C. W. Terrell, A. J. Jerri, R. O. Lyday, and D. Sperber (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Oct. 1960. 103p. Contract NBy-3185.

The basic objective of the work reported is to study, describe, and measure the transport of nuclear radiation through air ducts having walls of different materials. Particular emphasis is placed on full-scale concrete ducts which are intended for use as underground shelter entranceways and which contain a right-angle bend. It is shown that a modified albedo theory will rather accurately describe the transmission of both gammas and neutrons in lead and concrete ducts. Theory is compared with experimental measurements of γ dose and neutron-flux attenuation factors. Neutron number albedo measurements are made and reported. Work by various theorists and experimenters is included for completeness and comparison. (auth)

6236 (NP-9401) WMO BIBLIOGRAPHY ON RADIOACTIVITY IN THE ATMOSPHERE. Lists No. 1 and 2. (World Meteorological Organization, Geneva). 1959. 45p.

Three hundred and thirty-one references published up to June 1959 are presented of literature on radioactivity in the atmosphere. (C.H.)

6237 (NP-9506) PROCEDURES FOR MANAGING LARGE FALLOUT SHELTERS. Jiri Nehnevajsa (Dunlap and Associates, Stamford, Conn.). Apr. 1960. 216p. Contract CDM-SR-59-36.

A study is described which determined what it takes to manage and how to manage a large fall-out shelter in a structure especially built for this purpose. The shelter configuration and facilities for sleeping, feeding, medical, and sanitation requirements are generalized. Management of the facilities and operations for the prehabitancy; initial, routine, and final phases; and for emergencies are discussed in outline form. (T.R.H.)

6238 (NP-9507) THE USE OF EXISTING STRUCTURES AS FALLOUT SHELTERS. (Dunlap and Associates, Stamford, Conn.). Apr. 1960. 129p. Contract CDM-SR-59-36.

A manual is presented for use by towns in planning Civilian Defense shelters. Fundamental facts about fall-out and its hazards are presented, and a guide is offered for making a survey of possible shelters in existing buildings and comparing them with the population to be protected. After buildings are selected, the planning for accommodating the people is the next step. Finally, management of leaving the shelter is discussed. Appendices are included on case studies of seven typical buildings, a scale of supply for shelters, management structure for a 1000-person fall-out shelter, typical hardware designs and configurations, and protection factors in typical buildings. (T.R.H.)

6239 (SC-4492(RR)) ENVIRONMENTAL BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, MAY–DECEMBER 1957. R. E. Womelsduff, D. R. McGiboney, and H. L. Rarrick (Sandia Corp., Albuquerque, N. Mex.). Oct. 1960. 24p. OTS.

A report is given of the gross β-γ radioactivity of air samples collected by the Industrial Hygiene Division of the Sandia Laboratory of Sandia Corporation during the period May through Dec. 1957. (auth)

6240 (TID-6865) A DIFFUSION-DEPOSITION FALLOUT MODEL FOR THE KIWI-A REACTOR. Isaac Van der Hoven (Weather Bureau, Las Vegas, Nev.) Apr. 15, 1960. 14p. OTS.

A model is used to predict fall-out of radioactive particles resulting from the operation of a nuclear reactor. In the model it is assumed that particles are diffusing crosswind and vertically according to Sutton's continuous elevated point source equation and are also at the same time settling with a constant fall velocity. Two nuclear events having an observed fall-out pattern were used to test the model. Agreement between observed and computed patterns was well within acceptable limits of radiation intensities. (auth)

6241 (TID-7591(p.4-9)) GAMMA-RAY SPECTROMETRY IN ENVIRONMENTAL MONITORING. Gerald S. Golden (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.).

Applications of γ ray spectroscopy in qualitative and quantitative environmental monitoring and bio-analysis are discussed. The basic principles behind the pulse-height analysis of γ radiation are reviewed. It is concluded that γ-ray spectroscopy is useful as an adjunct to wet radiochemistry. Qualitatively it may serve as a guide to the radioactive purity of a product. Quantitatively it may eliminate some separations by permitting direct determinations in the sample. In the newer multichannel units connected to computers, the concentrations of several radionuclides in dynamic systems may be read off directly. (C.H.)

6242 (TID-7591(p.49-54)) PRESENT TRENDS IN ESTIMATION OF INTERNAL DOSE. Walter S. Snyder (Oak Ridge National Lab., Tenn.).

Present methods of estimating maximum permissible concentrations of radiation are discussed. Data obtained by consideration of a standard man, who represents the average adult worker with typical habits, are reviewed. The Recommendations of the National Committee on Radiation Protection and of the International Commission on Radiation Protection are discussed. (C.H.)

6243 (TID-7591(p.55-63)) FALLOUT DEPOSITION OF SEVEN NUCLIDES IN NEW YORK CITY DURING 1958. George A. Welford and William R. Collins, Jr. (New York Operations Office. Health and Safety Lab., AEC).

Monthly collections of fall-out materials were made in New York City and direct radiochemical measurements were made of the content of Sr^{90}, Sr^{89}, Cs^{137}, Zr^{95}, Ce^{144}, Y^{91}, and W^{185} in the samples collected during 1958. The age and origin of each monthly fall-out collection was estimated through nuclide ratios. The effect of rainfall on fall-out patterns is discussed. (C.H.)

6244 (TID-7591(p.99-106)) VARIOUS ASPECTS OF RADIOACTIVE STRONTIUM IN DAIRY CATTLE AND

MILK. R. G. Cragle and B. J. Demott (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Results are presented from a survey of the routes and rates of passage of radioactive strontium from roughage and grain fed to dairy cattle into milk. Factors affecting strontium uptake by cattle are discussed. Data are reviewed from a double-label $Sn^{89}-Ca^{45}$ experiment in cows. The possibility of removing strontium from milk by ion exchange resins is discussed. (C.H.)

6245 (TID-7593) SIXTH AEC AIR CLEANING CONFERENCE, JULY 7-9, 1959. (Division of Reactor Development, AEC; Harvard Univ., Boston. Air Cleaning Lab. and Idaho Operations Office. Health and Safety Div., AEC.) Oct. 1960. 393p. OTS.

A compilation is presented of the technical papers, notes, and tape recordings from a meeting in connection with air cleaning activities at AEC installations. The practical field experiences in effluent decontamination from reactors, fuel fabrication, and other laboratories and operations were reviewed. Separate abstracts were prepared for each of 41 papers. (T.R.H.)

6246 (TID-7593(p.1-8)) RADIOACTIVE PARTICULATE FALLOUT PROBLEMS AT THE ICPP. George Wehmann (Idaho Operations Office. Health and Safety Div., AEC).

The Site Survey Branch of the Health and Safety Division routinely conducts a monitoring program for determining levels of airborne radioactivity at the National Reactor Testing Station and its environs. Among methods utilized for the detection of particulates are horizontal collection plates of gummed paper which are located outside plant areas. During the summer of 1958 routine autoradiographic analysis of these samples indicated a particulate problem connected with the Idaho Chemical Processing Plant. The follow-up program is discussed, including particle distribution, size, isotopic content, and health hazard calculations. A special attachment to the microscope to facilitate location and identification of radioactive particles is also discussed. (auth)

6247 (TID-7593(p.9-17)) MINIMIZING GASEOUS AND PARTICULATE ACTIVITY IN IDAHO CHEMICAL PROCESSING PLANT OFF-GAS. G. K. Cederberg and J. R. Bower (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Bench-scale tests on iodine removal from RaLa process off-gas, reported at the last Air Cleaning Conference, were continued and evaluation tests of the Plant charcoal beds were completed. About 97% iodine-removal efficiency was demonstrated. Iodine-containing particles possibly formed by the gas-liquid contactor preceding the charcoal beds limit the efficiency of the bed in removing iodine. Radioactive particles are formed in the Fuel Element Cutting Facility by cutting, carrying, and charging techniques. Cyclones and filters are used for collection. Studies of particles originating in the vessel off-gas system and the waste solvent incinerator are directed toward minimizing their frequency and activity level. (auth)

6248 (TID-7593(p.18-25)) A METHOD FOR THE COLLECTION AND IDENTIFICATION OF RADIOACTIVE XENON AND KRYPTON. J. Kenneth Flygare, Jr., George Wehmann, Alan R. Harbertson, and Claude W. Sill (Idaho Operations Office. Health and Safety Div., AEC).

The Health and Safety Division is responsible for radioactive monitoring of out-plant areas of the National Reactor Testing Station. In order to determine if a leak existed in the RaLa off-gas system, a sampler capable of collecting radioactive xenon and krypton was required so that identification could be made. A sampler consisting of a "U"-shaped copper tube filled with activated carbon and cooled in liquid nitrogen has proved very effective. Two sizes have been made using $\frac{3}{4}$- and $1\frac{1}{2}$-in. tubing. The collection efficiency for xenon and krypton was essentially 100% at flow rates of 1 cfm even with the smaller sampler. Several such samplers were used at strategic locations and disclosed some leaks in the process system. Retention of xenon and krypton in activated carbon at room temperature is also discussed. (auth)

6249 (TID-7593(p.26-37)) WASTE CALCINATION OFF-GAS STUDIES. B. R. Wheeler (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Development studies concerned with treatment of off-gas from the waste calcination facilities currently being installed at the Idaho Chemical Processing Plant are described. Fission products contained in dust from the calciner make an essentially 100% gas-solid separation mandatory. Calcination conditions determine the size and concentration of solids in the off-gas. Data from the evaluation of venturi scrubbers on a pilot plant calciner show that all but 1.6×10^{-3} grains of solids per cubic foot of gas can be removed. Tests with a venturi scrubber and electrostatic precipitator independent of the cold calciner indicate that a gas containing only 1.5×10^{-8} grains of solids per cubic foot of gas may be attained at the expense of 10 to 15 in. mercury pressure drop across the venturi scrubber. (auth)

6250 (TID-7593(p.38-41)) THE SIGNIFICANCE OF THE AIR CLEANING PROBLEM IN AIRCRAFT NUCLEAR PROPULSION. Robert E. Baker (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati).

The HTRE and its off-gas monitoring and disposal problems are discussed. (T.R.H.)

6251 (TID-7593(p.42-6)) EXPERIENCE WITH NON-FILTERED AIR SYSTEMS AT THE IDAHO TEST STATION. R. B. O'Brien (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati).

Experimental direct-cycle aircraft nuclear power plants are ground tested at the ANP Area, National Reactor Testing Station, without air cleaning. Effluent hazards are minimized by a system of meteorological control. To date, this system has proved to be successful in controlling the doses to humans and may prove to be adequate for full-scale aircraft powerplant tests. Even if air cleaning of the effluent proves to be necessary in the future, a meteorological control program will serve to reduce the requirements of the air cleaning system, thereby reducing its cost. (auth)

6252 (TID-7593(p.47-50)) AIR CLEANING IN ANP EXPERIMENTS AT THE ETR AND MTR. D. C. Foster (General Electric Co. Aircraft Nuclear Propulsion Dept., Idaho Falls, Idaho).

The pre-stack disposal treatment of effluents from ETR and MTR tests of ANP fuel elements is described. It consists of a particle removal stage, iodine removal, and a decay-filter system. The filter system uses two silver-plated fiber frax beds with absolute filters and a delay tank between. (T.R.H.)

6253 (TID-7593(p.51-4)) PROPOSED SIDE LOOP PROGRAM AT THE IET. C. L. Storrs and D. C. Foster (General Electric Co. Aircraft Nuclear Propulsion Dept., Idaho Falls, Idaho).

The side-filter loop at IET is described. This facility is to provide pilot plant experience for a full-scale filter design. It draws off 5 to 10% of the IET exhaust and passes it through an electrostatic precipitator. It has a capacity of 14,000 cfm up to 900°F. (T.R.H.)

6254 (TID-7593(p.55-67)) WASTE CALCINER OFF-GAS SYSTEM. E. F. Edwards (Fluor Corp., Ltd., Los Angeles).

Provision for decontamination of the spent fluidizing air and other calciner off-gases presented major problems in the design of the pilot plant now being constructed at the National Reactor Testing Station for converting ICPP aluminum nitrate wastes to solids. In passing through the fluidized bed, the fluidizing air entrains radioactive particulate matter, a volatile radioactive fission product, and the oxides of nitrogen formed in the calcination reactions. The off-gas cleaning system adopted for the Waste Calciner is described, and some of the process considerations that entered into its design are given. Expected performance is given for the various types of air cleaning equipment employed. Particular emphasis is placed on the novel operations involved in the use of silica gel as a medium for adsorbing ruthenium and trapping dust. A new fixed-bed cleaning method is described for removing the dust and ruthenium trapped in the silica gel. The operability of this and other ruthenium adsorber operations is substantiated by the results of a research program designed to test the mechanical performance of this equipment. (auth)

6255 (TID-7593(p.68-75)) THE ADSORPTION OF VOLATILE RUTHENIUM ON SILICA GEL. D. W. Rhodes (Phillips Petroleum Co., Idaho Falls, Idaho).

The removal of volatile ruthenium by solid adsorbers from an air–nitric acid–water vapor phase was investigated. Silica gel was selected because it exhibited high affinity for ruthenium and the adsorbed ruthenium could be removed from the silica gel by washing with water. Decontamination factors obtained were in the range 100 to 1000 and total loadings as great as 58 g of ruthenium per cubic foot of silica gel were experienced without obtaining a breakthrough of ruthenium. (auth)

6256 (TID-7593(p.76-88)) MEASUREMENTS OF ATMOSPHERIC DIFFUSION FROM AN ELEVATED SOURCE. Norman E. Bowne (Weather Bureau, Idaho Falls, Idaho).

Diffusion from an elevated source under lapse conditions was measured utilizing uranine dye as a tracer. Comprehensive measurements of temperature and vertical and horizontal wind fluctuations were made at several levels on a 150-ft tower. The meteorological parameters are correlated with the ground-level air concentrations in an effort to establish predictors directly from Eulerian meteorological data. The effects of wind direction shear in the vertical on the maximum ground concentration are discussed. Techniques of dispersal, collection, and analysis, and the results of particle-size counting are included. Diffusion parameters measured from the dye concentrations are included and compared with those presently used at the National Reactor Testing Station. (auth)

6257 (TID-7593(p.89-99)) ESTIMATES OF ACCUMULATED EXPOSURES AND ENVIRONMENTAL BUILD-UP OF RADIOACTIVITY. Walter M. Culkowski (Weather Bureau, Oak Ridge, Tenn.).

A simple method for estimating long-term effluent concentration and deposition values based on Sutton's and Chamberlain's equations is presented. Calculations of concentration and deposition are straight forward, and become especially convenient if averaged wind data are employed. (auth)

6258 (TID-7593(p.100-102)) ANL AIR CLEANING RÉSUMÉ. C. L. Cheever (Argonne National Lab., Ill.).

Various types of air-cleaning equipment used at Argonne National Laboratory are briefly described, and air-cleaning plans for the Fuels Technology Center are discussed. (T.R.H.)

6259 (TID-7593(p.103-5)) SUMMARY OF AIR CLEANING ACTIVITIES AT ATOMICS INTERNATIONAL. E. C. Hickey (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Activities at Atomics International are conducted primarily at the reactor, hot-cell, and critical assembly site in the Santa Susana Mountains and at the research and fuel-element fabrication facilities in Canoga Park. Expanding research activities are requiring new air-cleaning equipment. The ventilation system of the recently activated fuel-element development and fabrication facility is described. (T.R.H.)

6260 (TID-7593(p.106-10)) SUMMARY OF AIR-CLEANING ACTIVITIES. Myron D. Thaxter (California. Univ., Berkeley. Lawrence Radiation Lab.).

The air-cleaning policy of the Lawrence Radiation Laboratory includes studies for improvement of methods and equipment. Among new developments and applications are sampling equipment and scrubbing or decontamination assemblies; further investigations are needed. (auth)

6261 (TID-7593(p.114-17)) A SUMMARY OF AIR CLEANING ACTIVITIES AT THE SAVANNAH RIVER PLANT. J. J. Croley, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

Current air-cleaning practices at SRP utilize a variety of techniques directed at securing a maximum decontamination factor for radioactive gases and particulate matter. The most commonly used device is the high-efficiency package filter. All "critical" locations where a potential fire hazard exists employ fireproof type filters. Other filter installations utilize the fire-retardant high-efficiency type filter as an economic factor until the current inventory of these filters is exhausted. Future plans visualize the use of only the fireproof high-efficiency filter at this Plant. Air-cleaning experiences at the Savannah River Plant were good with no problems worthy of discussion. (auth)

6262 (TID-7593(p.118-21)) FILTER EFFICIENCY STUDIES AT GOODYEAR ATOMIC CORPORATION. P. Diamond (Goodyear Atomic Corp., Portsmouth, Ohio).

Studies were conducted at Goodyear Atomic Corporation to evaluate the efficiencies of air filters and to gather data which could be used as bases in establishing effective filter cleaning and oiling schedules. Two types of filters were tested under various conditions, and corresponding efficiencies were determined. A direct relationship was found to exist between the degree of louver opening and filter efficiency. The resistance across filter banks was found to increase over relatively long periods of time. The methods employed during the studies and the results obtained were used to determine filter efficiencies and establish effective cleaning and oiling schedules. (auth)

6263 (TID-7593(p.122-6)) SUMMARY OF AIR CLEANING ACTIVITIES AT BROOKHAVEN. Lee Gemmell (Brookhaven National Lab., Upton, N. Y.).

A number of radioactive peaks have been seen on the

dust monitor located in the cooling air of the BNL Research Reactor. These peaks are much more pronounced since the installation of the new enriched fuel in August 1958. Even though this radioactivity represents no health hazard to the environment, a study was made to determine the cause of these peaks. The results of this study were inconclusive and showed only that major changes in meteorological conditions bring changes in peaks, but no specific correlations were made. A study is in progress to test the chemical combination of iodine and bromine on silver-plated copper gauze at different temperatures. No results are available. The Meteorology and Health Physics Divisions are studying the size, shape, concentration, and height of the cooling air plume from the research reactor under various weather conditions using the radioargon in the air plume as the trace element. Preliminary results look satisfactory. (auth)

6264 (TID-7593(p.127-30)) AIR CLEANING PRACTICE AT U.K.A.E.A., ALDERMASTON. F. J. Hall and S. E. Smith (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

Air-cleaning requirements, the design of air-cleaning systems, and the development of filters are discussed. The facilities involved are labs and shops where uranium, plutonium, and beryllium are handled. The system design includes filters, installation, and air treatment. (T.R.H.)

6265 (TID-7593(p.131-3)) SUMMARY OF IMPORTANT AIR CLEANING ACTIVITIES AT FMPC, FERNALD, OHIO. C. H. Stevens (National Lead Co. of Ohio, Fernald).

Four new installations are described. One was needed to collect very fine dust particles, and some difficulty in maintaining a constant pressure drop over the bag was encountered. Another project was a drumming station that eliminated dust leakage to the room while filling drums. A booth for separating uranium ingots from molds was built. A plant that burned off 5%-enriched sludges is also reported. (T.R.H.)

6266 (TID-7593(p.134-9)) STACK SAMPLING PROCEDURE AT THE NATIONAL LEAD COMPANY OF OHIO. Robert H. Starkey (National Lead Co. of Ohio, Cincinnati).

The stack sampling procedure and equipment at National Lead Company are described pictorially. The procedure is accurate within ±20%. (T.R.H.)

6267 (TID-7593(p.140-50)) AIR CLEANING AT THE KNOLLS ATOMIC POWER LABORATORY. T. T. Porembski (Knolls Atomic Power Lab., Schenectady, N. Y.).

A description is given of the newly designed activated carbon and stack system that will handle the radioactive iodine vapor and will be operated in conjunction with the existing systems in the Radioactive Materials Laboratory. The new system will consist of a 17,200-cfm fan and filtering facility and will employ twenty four 24- by 24-in. commercial-activated carbon filters operating together with a 105-ft stack. The over-all radioactive iodine concentration reduction factor will be in the order of 4×10^4. In the event of a radiation incident or equipment failure, back-up features are included to safeguard against the spread of radioactive contamination. (auth)

6268 (TID-7593(p.151-6)) ADDITIONAL OFF-GAS FACILITY. A. B. Fuller (Oak Ridge National Lab., Tenn.).

Some considerations in the design of additional radioactive off-gas cleaning and handling facilities at ORNL are given. Present equipment will handle 2000 cfm with a Cottrell precipitator, absolute filters, and a 250-ft brick stack. In 3 years a 4800-cfm capacity will be needed. The new facility and its equipment are described and discussed. (T.R.H.)

6269 (TID-7593(p.157-60)) CONDITION OF COMMERCIAL HIGH-EFFICIENCY FILTERS UPON RECEIPT OR INSTALLATION. Myron D. Thaxter (California. Univ., Berkeley. Lawrence Radiation Lab.).

The quality of fabrication of commercial filters was studied. Rejections of 80 and 100% of certain shipments as received at UCLRL are reported. Some of the defects observed are depicted. (T.R.H.)

6270 (TID-7593(p.161-81)) FILTER RATING AND TESTING PROGRAM. Humphrey Gilbert (Atomic Energy Commission, Washington, D. C.) and George J. Hurwitz (Army Chemical Center, Md.).

A study was made of 12 high-efficiency filters manufactured by three different companies. The samples were taken at random from filter stocks of atomic energy plants and tested for resistance and penetration on Army Chemical Corps equipment at Edgewood, Md. The results are presented and discussed. It is concluded that all filters received will have to be inspected and tested before acceptance. (T.R.H.)

6271 (TID-7593(p.182-98)) THE INSTALLATION, HANDLING AND STORAGE OF HIGH EFFICIENCY FILTERS. W. J. Richardson and J. H. Palmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The importance of proper handling, storage, and installation of high-efficiency filters is emphasized, and detailed instructions to ensure proper care are given. Some test installations were set up at Hanford to check installation accuracy. The tests showed that a great deal of care needs to be exercised in this operation. (T.R.H.)

6272 (TID-7593(p.199-216)) THE DISPOSAL OF RADIOACTIVE FISSION GASES BY ADSORPTION. R. D. Ackley, R. E. Adams, and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.).

In the operation of nuclear reactors, nuclear fuel reprocessing plants, and in-pile experiments, special provision must be made for disposal of gaseous fission products to prevent contamination of the atmosphere to an unacceptable degree. A disposal process is described in which the noble gas-fission products, krypton and xenon, are delayed relative to the sweep gas by physical adsorption as they pass through an adsorbent such as activated charcoal. A theoretical expression describing this process was developed, using a theoretical plate analysis, and was verified experimentally. The retention time for a gas present in trace concentration is proportional to the amount of charcoal in the adsorber and to the adsorption coefficient which is evaluated experimentally for a particular combination of materials and conditions. The retention time is inversely proportional to the volume flow rate of the sweep gas. The retention times of experimental adsorbers were measured by a radioactive tracer technique using Kr^{85} and Xe^{133} to typify fission gases. Retention times were measured for various adsorbents including different grades of activated charcoal, silica gel, activated alumina, and molecular sieve materials. Activated charcoal was the most effective adsorbent. Retention times were measured using He, H, A, N, O, air, CO_2, Freon-12, and Kr as sweep gases, individually. Retention time decreases logarithmically as temperature increases. Water vapor reduces the retention time for krypton on charcoal as does CO_2. Krypton inter-

feres negligibly up to 1000 μ partial pressure. Provision must be made for the dissipation of heat from radioactive decay. Ignition temperatures for charcoal in oxygen were determined, and methods of prevention and control of charcoal fires were investigated. Experimental results described were used to design off-gas adsorber systems for in-pile experiments and to analyze the performance of an adsorber for a homogeneous circulating fuel reactor. (auth)

6273 (TID-7593(p.228-35)) VENTILATION SYSTEMS AT ATOMICS INTERNATIONAL. A. R. Piccot (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

A brief summary of ventilation systems employed on reactors, hot cells, and critical facilities designed and/or operated by Atomics International is presented. The two power reactors discussed are contrasted by use of a rather loose building containment system in one (Sodium Reactor Experiment) and a very tight vapor container in the other (Piqua Organic Moderated Reactor). Similarly, of the two hot cells described, one operates with a comparatively large volume air flow, the other with a very low ventilation rate. Of the two remaining facilities considered, the Organic Moderated Reactor Critical Facility employs a somewhat unique dual ventilation system to avoid filter plugging by nonradioactive organic condensate. The Kinetic Experiment Water Boiler uses a sealed static atmosphere during reactor operation with subsequent high-volume flushing before re-entry of the test building. (auth)

6274 (TID-7593(p.236-7)) SUMMARY OF AIR CLEANING ACTIVITIES AT CHALK RIVER. J. Neal (Atomic Energy of Canada Ltd., Chalk River, Ont.).

The experience with the deep-bed roughing filters in the NRX Reactor accident is related, and the new filters installed after the damaged reactor was replaced are described. This new system incorporated 32 1000-cfm filters in four plenums. Upon start-up an excessive amount of radioactivity was observed passing the filters, and inspection revealed that damage had incurred during installation. An inspection group for such inspection was set up, and its recommendations are offered. (T.R.H.)

6275 (TID-7593(p.238-43)) HIGH-EFFICIENCY, HIGH-VELOCITY ELECTROSTATIC PRECIPITATORS. J. A. Young (Naval Research Lab., Washington, D. C.).

Naval Research Laboratory investigation of electrostatic precipitators is described. Improvements in sealing and gaskets and in use of pre-filters resulted in performance gains for early two-stage units. Feasibility studies were carried out aboard ship with impressive results. Further basic research was initiated to produce a unit that would operate at maximum flow rate and provide aerosol penetration of less than 0.1%, pressure drop not to exceed 1 in., and a maximum of 0.1-ppm ozone. A 1500-cfm two-stage tube type unit resulted. A 9500-cfm unit is also described. (T.R.H.)

6276 (TID-7593(p.244-9)) THE USE OF IODINE AS AN INDICATOR FOR REACTOR MONITORING. J. J. Sabo, J. E. Martin, and R. F. Grossman (Public Health Service, Idaho Falls, Idaho).

Radioactive iodine is a positive indicator of reactor fission products and distinguishes between these and neutron activation isotopes which are of far less importance biologically. A comparatively simple method for collecting iodines is the use of filter paper or filter tape treated with silver nitrate to give Ag^0 and Ag^+. A treated tape lends itself to a continuous fission product monitor; the use of activity read-out and γ energy discrimination can easily be employed. Laboratory evaluation of silver nitrate-treated paper gave a 95% collection efficiency for gaseous iodine. Iodine collection efficiencies varying from 40 to 95% were characteristic of treated paper when the Chemical Processing Plant was used as a source. These erratic results were thought to be due to part of the iodine entering into a complex chemical form less susceptible to collection by the silver iodide-treated paper. Using an air-cooled reactor as a source, the treated paper collected over 55% of the gaseous iodine. The collection efficiency for total iodine—gaseous and iodine acting as particulate—was over 95%. (auth)

6277 (TID-7593(p.250-6)) PROGRESS ON THE UNIVERSITY OF ILLINOIS CONTRACT. H. F. Johnstone (Illinois. Univ., Urbana. Engineering Experiment Station).

A brief summary is presented of work on the properties and behavior of aerosols as related to air pollution problems at atomic energy plants. (T.R.H.)

6278 (TID-7593(p.257-90)) ECONOMIC SURVEY OF AIR AND GAS CLEANING OPERATIONS WITHIN THE AEC. J. J. Fitzgerald, L. Silverman, R. Dennis, and C. E. Billings (Harvard Univ., Boston. School of Public Health).

A number of AEC sites prepared analyses of the technical and economic aspects of their air-cleaning activities. The data have been compiled and are to be summarized later. An appendix including some of these data is presented. The study to date indicates the need for an improved system of communication. (T.R.H.)

6279 (TID-7593(p.291-311)) PROGRESS REPORT ON HARVARD-AMERICAN IRON AND STEEL INSTITUTE RESEARCH PROJECT. Lester H. Levenbaum, Charles E. Billings, Nari Malani, Richard Dennis, and Leslie Silverman (Harvard Univ., Boston. School of Public Health).

Research studies on removal of fine fumes (<0.5 μ) from high-temperature gases (1000°F) are being conducted at Harvard for the American Iron and Steel Institute. Four main phases of this project are discussed: agglomeration of fine fume; heat-transfer characteristics of rotary screw agglomerators; shock wave cleaning of mineral wool filters; and pilot plant investigations of use of mineral wool for high-temperature fume filtration. Through agglomeration, submicron particles in metallurgical furnace effluents can be increased in size, facilitating their removal by fiber filters and extending filter life. The rotary screw agglomerator used for this purpose has shown a heat-transfer rate in excess of what normally might be expected, which considerably reduces (100 to 600°F) the temperature of gases going to the filtering unit. Shock wave cleaning of mineral wool filters was used to extend filter life in laboratory and field units as well as to reduce space requirements on a prototype unit. Using this shock wave cleaning method, as well as features from previous pilot plants, we have had very encouraging results on a 2000-cfm mineral wool filtering unit operated on fume from open hearth and electric furnaces. (auth)

6280 (TID-7593(p.312-21)) DEVELOPMENT OF AN IONIZATION DETECTOR FOR THE MEASUREMENT OF AEROSOL PARTICLE CONCENTRATIONS. R. E. Yoder and L. Silverman (Harvard Univ., Boston. School of Public Health).

A portable instrument was developed which can readily

detect aerosols in concentrations from 2×10^3 particles/cm^3 to 1×10^9 particles/cm^3. The instrument consists of two ionization chambers connected as series arms of a Wheatstone bridge. The ionization is produced by a radium D foil lying on the inner chamber wall. Aerosol particles passing through one of the ion chambers will carry away some of the ions in the sensitive volume and a decrease in the ion current will result. The change in current is proportional to the particle concentration. A second ion chamber will compensate for changes in the carrier gas composition and battery fluctuations. The complete instrument weighs less than 2 lb, exclusive of a vacuum pump capable of drawing 5 liters per minute. (auth)

6281 (TID-7593(p.322-43)) IODINE COLLECTION STUDIES. Leslie Silverman, Richard Dennis, Edward Kristal, and Felix Stein (Harvard Univ., Boston. School of Public Health).

Several methods for the removal of radioactive iodine from process and laboratory gas streams are under investigation by the Harvard Air Cleaning Laboratory. Major test objectives are to develop collectors that afford at least 90% I^{131} collection; have low resistance; are relatively inexpensive and easy to fabricate and maintain; have a long service life, i.e., up to 2 years, in terms of holding capacity and corrosion resistance; can function at gas temperatures up to 300°C; and are noncombustible. None of the collectors now in field use, i.e., Hanford silver reductor, caustic scrubbers, and activated carbon, satisfies all of the above requirements. Preliminary studies were made with normal I^{127} to simplify analytical and handling techniques during the screening phase of the study. Of the several chemical and metallic coatings applied to slag wool fibers (KI, $AgNO_3$, Cd, Cd–Sb, and Ag) vacuum-plated silver on slag wool showed the highest efficiency, >99.9% and lowest resistance, 1.1 in. water. Tests on metal ribbon (Sn and Cu) and Zn granules indicated a very high efficiency for Cu, (>99.99%) and low resistance (0.1 in. water at 60 ft. per min. face velocity). Activated carbon was the only adsorbent showing high efficiency, but the resistance was considerably greater, 4-5 in. water. Copper ribbon performed well at room temperature but failed after 25 hr of hot (300°C) operation. Silver-plated copper ribbon showed no sign of breakdown after 100 hr of hot operation. Presence of moisture and high temperatures improved performance of both copper and silver-copper ribbon, indicating that chemisorption was the primary iodine-collecting mechanism. NH_3, HNO_3, and H_2S did not interfere with iodine collection. Special tests on silver-copper ribbon with mixed isotopes (1 mg/m^3 I^{127} and 10^{-8} to 10^{-6} mg/m^3 I^{131}) showed that iodine collection was concentration dependent and was the same for I^{127} and I^{131}. Increased metal surface area per unit collector volume, attained by increasing ribbon dimensions or increasing the packing density, improved collection efficiency significantly. Iodine-131 efficiency of silver-copper (25- by 2-mil ribbon, 33 lb/cu ft) was estimated to be 50% with an inlet iodine concentration of 10^{-6} mg/m^3 (123 $\mu c/m^3$). For the same inlet loading the efficiencies of 5- by 4-mil ribbon (58 lb/cu ft) and 3- by 2-mil ribbon (71 lb/cu ft) were estimated to be >97 and >98%, respectively. (auth)

6282 (TID-7593(p.344-64)) SPECIAL INCINERATION STUDIES–INSTITUTIONAL DESIGN. Richard Dennis, Frederick L. Muller, Edward Kristal, and Leslie Silverman (Harvard Univ., Boston. School of Public Health).

The Harvard Air Cleaning Laboratory is currently engaged in designing incineration and gas-cleaning apparatus for the disposal of low-level radioactive wastes from hospitals and biological laboratories. Previously, this laboratory had attempted to design a gas cleaning system for use with the BOMAEC-30 incinerator, developed by the U. S. Bureau of Mines. Operational and leakage problems, however, indicated that design changes would be necessary for practical application of the unit. Tests on a small (10 to 15 lb/hr burning rate) commercial home incinerator showed combustion characteristics which were nearly as good as those noted for the BOMAEC-30. Since the cost of the former unit was in the range of $100, it appeared feasible to construct a small incinerator from a 55-gal drum with provision for accurate gas flow and temperature measurements. Our first experimental model was designed for single inlet, tangential, over-fire air admittance (somewhat like the Bureau of Mines unit). However, the burning chamber was lined with a 2-in. layer of firebrick rather than stainless steel. A charge pre-drying chamber located above the burning section proved unsuccessful as a means of handling high-moisture waste. Therefore a single side charge door was installed with a sliding rack to support wet materials within the burning chamber while the previous charge was burning. This procedure enabled continuous charging of wet materials once the burning chamber was at temperature, >2000°F. A secondary brick-lined cylindrical chamber located immediately above the burning area allowed for further high-temperature combustion of unburned volatiles and particulates, since a secondary air inlet was located at the base of this section. Effluent gas was cooled by dilution air which entered tangentially at the top of this chamber. Test results, based upon burning rate and volume of CO_2 produced per lb of charge, show that the over-all performance of the current incinerator design, ACL II, is superior to that of the BOMAEC, based on cost, simplicity of operation, and the fact that wet wastes, up to 50% moisture, can be burned satisfactorily without the need for auxiliary gas firing. Gas-cleaning apparatus consists of a basket type filter, 10-sq ft surface, composed of graded glass fibers. Our present intention is to filter hot (600 to 800°F) to avoid installation of cooling and reheating apparatus. (auth)

6283 (TID-7593(p.365-74)) A REVIEW OF THE EXISTING REACTOR CONFINEMENT PROGRAM AT HANFORD. R. C. Walker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The current status of the confinement program relative to the existing production reactors at Hanford is summarized. Included is a description of the over-all system plus a more detailed review of the principal system components: fog spray, filters, ventilation control, and the electrical and instrumentation being provided for necessary control and monitoring of the entire system. A brief outline of the associated testing and development programs is also included as well as several charts which more clearly delineate the physical and control aspects of the system. (auth)

6284 (TID-7593(p.375-8)) PRELIMINARY REPORT OF ACCELERATED LIFE TESTS ON CERTAIN AIR-CLEANING FILTER MEDIA. D. E. Wisehart (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An accelerated life test procedure is given, and results on several media are presented. Test aerosols of NaCl and dusts were generated and drawn through the media. (T.R.H.)

6285 (TID-7593(p.379-85)) THE T-SONDE, A LOW LEVEL AIR TEMPERATURE MEASURING DEVICE. C. Ray Dickson and Harry R. Mansfield (Weather Bureau, Idaho Falls, Idaho).

A system for study of temperature-height relations in the atmosphere to heights of 1500 to 2000 m is proposed. The T-sonde system consists of a transmitter and thermistor and ground receiving equipment. Calibration of the sonde, design of the vehicle, and performance of the system are described. It is concluded that the system has reasonable accuracy and should show the complete temperature structure of the lower atmosphere. (T.R.H.)

6286 (AEC-tr-4312) CASUALTY FIGURES AND THE EXTENT OF THE DAMAGE CAUSED BY THE ATOMIC BOMBS DROPPED ON HIROSHIMA AND NAGASAKI. (Verlustziffern und Schadensausmass Nach den Atombombenwurfen auf Hiroshima und Nagasaki). Hubert Keim. Translated from Strahlentherapie 108, 594-601(1959). 11p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 12306.

6287 (JPRS-5977) DEACTIVATION OF DRINKING WATER CONTAINING RADIOACTIVE PHOSPHORUS BY THE METHOD OF CONTACT COAGULATION. (Dezaktivatsiya Pit'evoi Vody, Soderzhashchei Radioaktivnyi Fosfor, Metodom Kontaktnoi Koagulyatsii). Z. Ya. Gorodisheher and N. I. Mashneva. Translated from Gigiena i Sanit. 25, No. 7, 56-60(1960). 10p. OTS.

Preliminary results are given from a study of contact coagulation for decontamination of drinking water. Two columns of different lengths were used, water containing $Na_3(PO_4)_2$-P^{32} being mixed with $Al_2(SO_4)_3$ and passed through. The filter deactivates the water by sorption of the P^{32}. The sorptive agent is metal hydroxide gel. The P^{32} is removed from the column by a water backwash. (T.R.H.)

6288 EVALUATION OF RADIATION HAZARDS CREATED BY THORON AND THORON DAUGHTERS. Richard L. Blanchard and Duncan A. Holaday. Am. Ind. Hyg. Assoc. J. 21, 201-6(1960) June.

In estimating the relative hazards created by the inhalation of thoron and thoron daughters, certain assumptions were required because of the incomplete knowledge of the biological behavior of these elements or were employed to simplify the calculations. These assumptions were that all daughters produced by the decay of thoron in the lungs were retained in the lungs until they decay to stable lead; the potential α energy of the daughters was calculated only from the energy released by the decay of ThB to stable lead; thorium A decayed 100% of the time to thorium B; thorium C was considered to decay 33.2% of the time by emission of 6.07 Mev α particles; and that only the tissue dose delivered by the α particles was considered. These calculations resulted in several interesting conclusions. They showed that ventilation is much more effective in reducing atmospheric concentrations of thoron daughters than it is for radon daughters. Conversely, practical rates of ventilation will not appreciably lower atmospheric concentrations of thoron. In comparison with radon daughters, much longer sampling times are feasible. This is important, as thoron daughter samples collected in the field will usually have quite small amounts of α activity and will require a more sensitive instrument than those which are satisfactory for radon daughter measurements. The calculations indicate that a concentration of only 8 $\mu\mu$c of thoron per liter at equilibrium with its daughters is equivalent in potential α energy to a concentration of 100 $\mu\mu$c radon per liter at equilibrium (1.3×10^5 Mev/l). At equilibrium the calculated lung radiation dose from thoron is insignificant compared to the calculated lung radiation dose from thoron daughters. For example, a concentration of 5360 $\mu\mu$c of thoron per liter delivers a lung radiation dose equivalent to that from a working level concentration of thoron daughters. The calculations also indicate that, on an activity basis, the permissible atmospheric concentration of thoron daughters should be much less than the level for radon daughters. Therefore, all situations involving the processing and use of appreciable amounts of thorium ores, salts, or metal should be surveyed to determine if significant amounts of these elements are present in the workroom atmosphere. (Public Health Engr. Abstr. 40 (1960) Dec.)

6289 CONTRIBUTION TO THE STUDY OF PROCESSES FOR EXTERNAL DECONTAMINATION. EXPERIMENTATION WITH A NEW PRODUCT IN THE CASE OF RADIOACTIVE CONTAMINATION OF THE TEGUMENTS. J. Toulet and J. Tabernat. Arch. maladies profess. méd. travail et sécurité sociale 20, 272-82(1959). (In French) (CEA-1289)

The general principles of external decontamination are surveyed, and the organizational elements concerned with this problem in a nuclear research center are discussed. Dermatological experiments with lotion M.O.8.385 and studies of its decontaminating ability in vitro are reported. M.O.8.385 is natural sulfur water with a predominance of sodium and silicon and with certain terpenic oils and other additives such as glycerine, diethyl glycol, benzylic acid, benzoic acid, boric acid, sodium borate, and EDTA. The experimental and clinical results lead to no definitive conclusions, but the lotion is of interest, along with other compounds, for its decontaminating power, especially when applied after the use of $KMnO_4$ or H_2O_2. (T.R.H.)

6290 SPACE HAZARDS. Douglas E. Smith (Argonne National Lab., Ill.). Federation Proc. 19, 40-2(1960) Sept.

Although man is about to venture into space for short periods of time and although one expects his safe return to earth, it is obvious that the hazards of space travel are manifold and great. It should be emphasized that considerable further exploration of both the space environment and the internal environment of the space ship is necessary before the dangers of space travel can be fully assessed. Among the most important efforts in these directions should be satellite experiments primarily designed for biological purposes. (auth)

6291 ON THE INTRODUCTION OF RAD UNIT INTO THE PRACTICE OF MEDICAL RADIOLOGY. M. Sh. Vainberg. Med. Radiol. 5, No. 10, 9-13(1960) Oct. (In Russian)

Introduction into the dosimetry of rad units is being delayed by the absence of practical dosimeters, which would enable measurements directly in rads. A technique is described which is conducive to a rapid change-over to rad units in the practice of medical radiology. (auth)

6292 ON MAXIMAL PERMISSIBLE CONCENTRATION OF SHORT-LIVING DAUGHTER PRODUCTS OF RADON FISSION. I. L. Shalaev. Med. Radiol. 5, No. 10, 56-61(1961) Oct. (In Russian)

A recommended value is given for the maximal permissible concentration for short-living products of radon fission in the air of industrial premises, and a description is given of the technique of its determination. (auth)

6293 AN APPARATUS FOR SIMULTANEOUS CONTROL OF SURFACE POLLUTION BY ALPHA- AND

BETA-ACTIVE SUBSTANCES. I. B. Keirim-Markus, V. V. Markelov, and L. N. Uspenskii. Med. Radiol. 5, No. 10, 68-72(1960) Oct. (In Russian)

For the purpose of dosimetric control in a radiochemical enterprise a scintillation detector is recommended with a surface area of 200 cm^2, enabling measurements of alpha- and beta-radiation. The results of studies of bilayer luminescent screens are presented and a block-scheme for the apparatus advocated. (auth)

6294 ON THE CONTAMINATION OF PLATINUM WITH FISSION PRODUCTS AND THE DECONTAMINATION OF CONTAMINATED PLATINUM WITH ACIDS. Tadashi Yanagihara, Hirozo Kimura, and Minoru Chiba. Nippon Kinzoku Gakkaishi 24, No. 7, 413-17(1960). (In Japanese and English)

The contamination of platinum with nuclear fission products, and its decontamination, were studied. Platinum plates were contaminated by soaking in a solution of fission products. The contamination increased with an increase of the soaking time, and was saturated in about 3 hr. It was confirmed by methods of autoradiography, electron microscopy, and optical microscopy that the contamination was markedly affected by the surface condition of platinum. A sample soaked in the solution of fission products for only a short time was easy to decontaminate with tap water and the amount of the residual contamination reached equilibrium more rapidly than in the long-soaked sample. HCl, HNO_3, H_2SO_4, H_3PO_4, and HF were tried for decontamination. The effect of temperature on the decontamination was very significant. The decontamination with HCl at high temperature was more effective than with the other acids. The decontamination with fused $KHSO_4$ was more effective than with the acids and other fused salts. Only one immersion of the contaminated platinum plate into fused $KHSO_4$ could remove 99.4% of the contamination. The degree of the contamination of platinum with fission products is very low and it is easy to decontaminate it with the decontaminating agents such as HCl and $KHSO_4$. (auth)

6295 DOSIMETRY CONVERSION FACTORS. Susanne Deutsch Ellis (Autometric Corp., New York) and R. Hobart Ellis, Jr. Nucleonics 18, No. 11, 210(1960) Nov.

Four tables designed to permit rapid conversion from one to another of the units for absorbed dose, absorbed dose rate, energy, and power are given. (M.C.G.)

6296 A RADIOACTIVE FALL-OUT STUDY AT MELBOURNE, AUSTRALIA. A. J. Dyer and S. A. Yeo. Tellus 12, No. 2, 195-9(1960) May.

Measurements of the radioactive fall-out occurring in weekly rainfall samples at Melbourne (Aspendale) are presented for the period June 1958 to February 1959. Radioactive decay analyses show the activity to have arisen from nuclear weapons tests carried out near the equator during the period April to September 1958. The results indicate that, despite presumably continuous dispersion, individual radioactive clouds maintain their discreteness and a limited E-W extent even after 6 or 9 months residence in the stratosphere. This property allows a poleward drift speed of order 1 m/sec and zonal circulation velocities ranging from 6 to 17 m/sec to be inferred. (Public Health Eng. Abstr. 40 (1960) Dec.)

6297 INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT FIRST ANNUAL MEETING, COLUMBUS, OHIO, JUNE 20-21, 1960. Pittsburgh, Institute of Nuclear Materials Management, 1960. 153p. $5.00.

Six papers and four panel discussions are included. The papers, of which five are abstracted, deal with problems in industrial reactor fuel control, U^{235} determination, and fuel processing economy. The discussions cover criticality monitoring, scrap reprocessing, shipper-receiver differences, and AEC leasing policies. (D.L.C.)

6298 NUCLEAR MATERIALS MANAGEMENT AT MALLINCKRODT NUCLEAR CORPORATION. Edward North (Mallinckrodt Nuclear Corp., Hematite, Mo.). p.5-10 of "Institute of Nuclear Materials Management First Annual Meeting, Columbus, Ohio, June 20-21, 1960."

The program of nuclear materials management in use at Mallinckrodt for maintaining the enrichment of materials processed for reactor use and preventing a critical mass from accumulating is described. The items discussed include the dividing of the conversion plant into three sections for high, intermediate, and low enrichments; equipment cleaning; criticality safety conditions; safe geometry equipment; residues; weekly inventories in the high enrichment area; and problems, e.g., duplication of effort, varying safety requirements, materials shipping, and transfer forms. (D.L.C.)

6299 FOUNDRY RADIATION PROTECTION MANUAL. Des Plaines, Ill., American Foundrymen's Society, Inc., 1960. 62p. $9.50.

A manual is presented which should enable a foundry to install and operate a safe radiography facility. Chapters cover the nature and sources of radiation in the foundry, health aspects of radiation, control of radiation in the foundry, radiation detection instruments, protection by time, distance, and shielding, handling sources of radiation, and a glossary. (D.L.C.)

6300 BACKGROUND MATERIAL FOR THE DEVELOPMENT OF RADIATION PROTECTION STANDARDS. Report No. 1. (Federal Radiation Council, Washington, D. C.). May 13, 1960. 47p. GPO.

The Federal Radiation Council was formed in 1959 to provide a Federal policy on human radiation exposure. A major function of the Council is to advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all Federal agencies in the formation of radiation standards and in the establishment and execution of programs of cooperation with States. Recommendations are presented for radiation protection during peacetime uses of radiation. It is postulated that periodic reviews will be necessary to incorporate new information as it develops. Summaries are included of knowledge on the biological effects of ionizing radiation on animals and man, sources of radiation exposure, basic guides for derivation of radiation protection standards, and factors affecting body burdens of radioactive materials. (C.H.)

6301 THE HAZARDS TO MAN OF NUCLEAR AND ALLIED RADIATIONS. A Second Report to the Medical Research Council. (Gt. Brit. Medical Research Council, London). 1960. 161p. 7s.(Her Majesty's Stationery Office, London).

The possible hazards to man from nuclear and allied radiations are reviewed. Topics discussed include the types of radiation and their biological effects; the effects of radiation on the health of the individual; the genetic effects of radiation; existing and expected levels of exposure to radiation; and an assessment of the hazards of radiation exposure to man. (C.H.)

6302 RADIOLOGICAL HEALTH DATA, MONTHLY REPORT, NOVEMBER 1960. Volume 1, No. 8. (Public Health Service, Washington, D. C.). 57p. (PB-161371-8). $1.00(OTS).

Data on environmental radiation levels and radioactivity in milk, air, and water samples collected at various sites in the U. S. are presented for the period Apr.–June 1960. (W.D.M.)

6303 RADIOLOGICAL HEALTH DATA MONTHLY REPORT, DECEMBER 1960. Volume 1, No. 9. (Public Health Service, Washington, D. C.). 56p. $1.00(OTS).

Data are tabulated on radioactivity in samples of milk collected during July 1960; Sr^{90} content of milk from various sources; radioactivity of particulates in air; radioactivity in samples of raw surface waters collected during June 1960; and Sr^{90} in samples of tap water collected from April through June 1960. Results are included from measurements of Sr^{90} concentrations in bread purchased in New York City between March and June 1960; radioactivity in samples of soil collected at Argonne National Laboratory; and measurements of environmental levels of radioactivity at AEC installations throughout the U. S. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

6304 (CNB-19) L'IMPIEGO DELLE RADIAZIONI IONIZZANTI PER LA CONSERVAZIONE DEGLI ALIMENTI. CONOSCENZE E PROSPETTIVE. (The Use of Ionizing Radiation for the Preservation of Food. Knowledge and Possibilities). A. Porretta (Stazione Sperimentale per l'Industria delle Conserve Alimentari, Parma, Italy). Sept. 1960. 148p.

A review is presented of the problems connected with the use of ionizing radiation for the sterilization, pasteurization, and disinfestation of foods. The effects of ionizing radiation on microorganisms, on enzymes, and on the basic components of foods are examined together with the advantages and disadvantages offered by the new preservation agent. (224 references) (auth)

6305 (NP-9657) ŹRÓDŁO ŚWIATŁA Z IZOTOPEM Kr-85. Report No. 175/III. (The Light Source with Kr-85 Isotope). P. Ya. Novatski, A. Kazimerski, E. Strykhal'ski, and Yu. Ridel (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Sept. 1960. 13p.

The isotope light sources developed in the Institute for Nuclear Research are described. The luminofor, consisting of zinc and cadmium sulfide activated with copper, is excited for light emission using β radiation of radioactive Kr^{85}. The luminance obtained on the window surface (55-mm diameter) of the source is about 3000 μl with 800 mc of krypton. The filling method of the source is also described. (auth)

6306 (NYO-2603) FISSION PRODUCT APPLICATIONS USING GASEOUS BETA SOURCES. Quarterly Progress Report No. 1 [for] Period Covered March 1, 1959–May 31, 1959. Hoke S. Miller (Air Reduction Co., Inc. Central Research Labs., Murray Hill, N. J.). 19p. Contract AT(30-1)-2343. OTS.

A unit for the use in chemical tests of Kr^{85} and the recovery of this isotope was designed and built. It is now being tested with inactive krypton. Tests with the radioisotope will be initiated upon receipt of a supply of Kr^{85}, which was ordered as soon as the license by the Atomic Energy Commission to use radioactive krypton was issued. (auth)

6307 (SRIA-19) INSTRUCTOR'S GUIDE: SURVEY OF NUCLEAR FUNDAMENTALS AND RADIOISOTOPE APPLICATIONS IN INDUSTRY. Leland H. Towle (Stanford Research Inst., Menlo Park, Calif.). July 1960. 94p. SRI Project No. IU-2922. Contract AT(04-3)-115, Project Agreement No. 16. GPO.

An outline is presented of a course of study designed for use in training workers engaged in work where radioisotopes are being used. It is assumed that these workers will not be technical experts in radiochemistry or nuclear physics. The course is intended to present the fundamentals of nuclear science, information concerning radioisotopes and their industrial uses and applications, their potential hazards, and some of the techniques used in their safe handling. This course is intended to meet the needs of those engaged in industrial uses of radioisotopes in radiography, gauging, and tracing. Lists of references and training films are included. (C.H.)

6308 (SRIA-20) DEVELOPMENT OF A TRAINING PROGRAM FOR RADIOISOTOPE WORKERS IN INDUSTRY. Howard M. Vollmer, Leland H. Towle, and Betty J. Maynard (Stanford Research Inst., Menlo Park, Calif.). July 1960. 130p. SRI Project No. IU-2922. Contract AT(04-3)-115, Project Agreement No. 16. GPO.

A survey was made to determine the scope and magnitude of workers' training needs that now exist or that may be expected to arise as a consequence of the introduction of radioisotope technology in American industry. Present radioisotope training programs are reviewed. Based upon the analysis of training needs of radioisotope workers in industry, an instructor's guide was prepared for a 32-hr course. The effectiveness of the course was surveyed. (C.H.)

6309 (SRIA-21) INSTRUCTOR'S GUIDE: RADIATION SAFETY. Leland H. Towle (Stanford Research Inst., Menlo Park, Calif.). July 1960. 94p. SRI Project No. IU-2923. Contract AT(04-3)-115, Project Agreement No. 15. GPO.

An outline is presented for a training course in the field of radiation safety. The course is designed to meet the needs of workers employed in a radiation area, but it may also be used as an introduction to the more specialized training required for such positions as radiation monitoring or assistant to the health physicist. Lists of training charts, training films, and references are included. (C.H.)

6310 (SRIA-22) DEVELOPMENT OF A RADIATION SAFETY TRAINING PROGRAM FOR INDUSTRIAL AND PUBLIC SERVICE PERSONNEL. Howard M. Vollmer, Leland H. Towle, and Betty J. Maynard (Stanford Research Inst., Menlo Park, Calif.). July 1960. 150p. SRI Project No. IU-2923. Contract AT(04-3)-115, Project Agreement No. 15. GPO.

A survey was made of the need for radiation protection training of industrial workers and public service personnel as a consequence of the increasing peacetime uses of nuclear technology. The needs of certain types of public service personnel were considered in terms of the various types of radiation hazards to the general public and the means commonly used to control these hazards in local communities. An important objective of a general survey

course would be to allay unnecessary fears and to develop realistic attitudes toward radiation hazards. (C.H.)

6311 (SRIA-23) RADIATION SAFETY TRAINING IN A NAVAL SHIPYARD; SOME MEANS OF ASSESSING TRAINING NEEDS AND EVALUATING COURSE EFFECTIVENESS. Howard M. Vollmer and Leland H. Towle (Stanford Research Inst., Menlo Park, Calif.). July 1960. 62p. SRI Project No. IU-2923. Contract AT(04-3)-115, Project Agreement No. 15. GPO.

A survey was made of training needs and course effectiveness in radiation safety training in a naval shipyard where nuclear-powered vessels are built, converted, or overhauled. The objectives of the survey were to demonstrate how analytical devices may be developed to measure knowledge about radiation safety and attitudes toward radiation hazards and to indicate how these may be used in a large industrial nuclear facility to assess training needs and to evaluate the effectiveness of a training course. (C.H.)

6312 (OTS-60-21151) EXPERIMENTS IN THE USE OF COBALT AND IODINE RADIOACTIVE ISOTOPES IN LAND IMPROVEMENT INVESTIGATIONS. (Opyt Primeneniya Radioaktivnykh Izotopov Kobal'ta Ioda v Meliorativnykh Issledovaniyakh). S. V. Astapov, V. A. Emel'yanov, and K. N. Shishkov. Translated from Gidrotekh. i Meliorats. 10, No. 1, 22-9(1958). 14p. (PST-Cat.-129). OTS.

The soil improvement laboratory of the All-Union Research Institute for Hydraulic Engineering and Reclamation carried out in 1956 the investigations of certain hydrophysical properties of soils and subsoils of the Meshchersk Plain with the use of radioactive isotopes Co^{60} and I^{131}. Radioactive cobalt was employed as a source of γ-radiation for determining the density (unit weight) of soil and the variations in soil moisture, whereas radioactive iodine was used as a tracer in studying, by the method of tracer atoms, the actual rate of ground water movements, the intensity of capillary rise of moisture in the capillary fringe of soils, and the permeability coefficient of saturated soils. The γ radiation of the radioactive cobalt and iodine isotopes was measured with an STS-5 counter. Pulses from its anode connected through a coaxial cable with a scaler system using cold cathode thyratrones and thence into an electro-mechanical counter which registered one impulse out of every 64. The scaler system and the counter (150 and 400 volts) were fed by layer-batteries (150 and 400 volts). For the determination of the groundwater flow velocities and of the permeability coefficient of soils, where no high accuracy in measuring the radioactivity of marked water was necessary, a D P-11B radiometer was used. (auth)

6313 RADIATION STERILIZATION OF FOOD. I. PROCEDURES FOR THE EVALUATION OF THE RADIATION RESISTANCE OF SPORES OF CLOSTRIDIUM BOTULINUM IN FOOD PRODUCTS. C. F. Schmidt and W. K. Nank. Food Research 25, 321-7(1960) May-June.

Procedures have been suggested for the evaluation of the resistance of spores of Clostridium botulinum in food products subjected to ionizing radiation and have been illustrated by representative data. The occurrence of nontoxic spoilage yielding either strongly toxic or questionably toxic cultures has been noted. Although a mixture of strains, 3 Type A and 2 Type B, was used as inoculum, all survivors produced Type A toxin; and it is suggested that the determination of radiation resistance with a suspension representing a mixture of strains is inadvisable. Approximately the same resistance of the inoculum was found in chicken parts, steak, and whole kernel corn; survival at 2.8; no survival at 3.0 megarad; radiation D value, 0.33 to 0.35 megarad. In pork loin, resistance appeared slightly lower but on the borderline of significance. Resistance of the suspension appeared definitely lower in green beans, based upon a comparison of D values. (Public Health Eng. Abstr. 40 (1960) Dec.)

6314 TREATMENT OF MEATS WITH IONISING RADIATIONS. V. RADIATION PASTEURISATION OF BEEF FOR CHILLED STORAGE. C. H. Lea, J. J. MacFarlane, and L. J. Parr (Low Temperature Research Station, Cambridge, Eng.). J. Sci. Food Agr. 11, 690-4(1960) Dec.

Small-scale experiments on the storage of cuts of beef and of beef fatty tissue at chilling temperatures showed that microbial spoilage is considerably retarded by doses of ionizing radiation between 25,000 and 100,000 rads, as indicated by a delay in the development of tainted odor and flavor, by a retarded appearance of visible bacterial growth, and by a slower rate of increase in the free fatty acid content of the fat. Symptoms of accelerated oxidation were also present, as indicated by the development during storage of a tallowy odor and flavor perceptible in the raw or lightly cooked fat. The yellow carotenoid pigment bleached noticeably, and peroxide accumulated more rapidly in the irradiated than in the control fat. All of these changes were most marked near to the surface exposed to the air. It is concluded that the margin between desirable and undesirable effects may be so small as to make the application of irradiation of doubtful benefit for the overseas transport of chilled beef. (auth)

6315 INSECT CONTROL BY GAMMA-IRRADIATION: AN APPRAISAL OF THE POTENTIALITIES AND PROBLEMS INVOLVED. P. B. Cornwell and J. O. Bull (Wantage Radiation Lab., Berks, Eng.). J. Sci. Food Agr. 11, 754-68(1960) Dec.

Experimental sources of Co^{60}, made radioactive by neutron irradiation, have been used during recent years for investigating the radiation susceptibility of insect pests. Lethal and sterilizing effects have been examined on species, strains, and developmental stages to evaluate the dose levels required for commercial treatment. The technical feasibility of using radiation as an insecticide is now established. Results of research and problems of application are examined in relation to the two potential methods of controlling insect pests by irradiation: indirect control by the release of sterilized adults and the direct treatment of infested products. Application of the first method, exemplified by work on screw-worm fly, is limited to very few species by a number of biological requirements. Direct treatment could have wider application for the control of all species infesting stored products. The most favorable products for radiation disinfestation are those handled in bulk at particular centers, and for this reason radiation treatment of grain has been examined in detail. The fundamental and applied problems of using γ-radiation for this purpose are discussed, and the relative merits of fumigation and radiation sterilization are compared. It is concluded that among factors that may influence the success of radiation disinfestation, bulk handling and the incorporation of treatment into established handling procedures must receive primary consideration. Gamma irradiation may eventually take its place as a useful means of insect control, but it is unlikely to displace conventional methods. (auth)

6316 ACCELERATOR-MADE TRACER SOLVES A MIXING PROBLEM. Oswald U. Anders (Dow Chemical Co., Midland, Mich.). Nucleonics 18, No. 12, 77-8(1960) Dec.

The advantages of a short-lived accelerator-made tracer are illustrated in a study of the mixing rate of a viscous rubber solution in a stirrer-agitated kettle. The tracer was 2.56 hr Mn^{56} produced by neutron irradiation of natural manganese. The final product was, for practical purposes, free of radioactivity after storage for two days. A representative point in the vat was chosen and the scatter of counting rates at that point observed. The counting rate became constant at this point when mixing was complete. Tracer requirements and production are discussed. (M.C.G.)

6317 FOOD PRESERVATION BY IRRADIATION. Supplement to CTR-357. OTS Selective Bibliography. Office of Technical Services, Washington, D. C. Mar. 1960. 5p. (SB-403). $0.10(OTS).

Forty-five references are presented on various aspects of the food irradiation program. (C.H.)

ISOTOPE SEPARATION

6318 (TID-5232) CHEMICAL PROCESSING EQUIPMENT: ELECTROMAGNETIC SEPARATION PROCESS. G. A. Akin, H. P. Kackenmaster, R. J. Schrader, J. W. Strohecker, and R. E. Tate, eds. (Tennessee Eastman Corp., Oak Ridge, Tenn.). Apr. 1947. Decl. Nov. 23, 1959. 510p. (NNES-1-12). OTS.

6319 (TID-5233) SEPARATION OF ISOTOPES IN CALUTRON UNITS. H. Wesley Savage, ed. (Tennessee Eastman Corp., Oak Ridge, Tenn.). Apr. 1947. Decl. Nov. 23, 1959. 441p. (NNES-1-7). OTS.

6320 (CEA-tr-R-1006) THÉORIE DE LA SÉPARATION CHROMATOGRAPHIQUE DES ISOTOPES. (Theory of Chromatographic Separation of Isotopes). S. E. Bresler. Translated into French by B. Vinogradoff from Zhur. Fiz. Khim. 32, 628-34(1958). 12p.

A differential equation was obtained which describes the separation of isotopes in a chromatographic column. The equation was solved for both the stationary and nonstationary states. This solution gives the value of maximum separation and the time required to establish the equilibrium state. The formulas obtained were then applied to experimental data on the separation of nitrogen isotopes. (tr-auth)

6321 AN H_2O-D_2O MODERATED REACTOR. W. P. Bebbington (E. I. du Pont de Nemours & Co., Aiken, S. C.). Nuclear Sci. and Eng. 8, 720(1960) Dec.

A discussion is given on the cost of concentrating D_2O for use as a reactor moderator. Of the total direct cost of manufacturing 99.8% D_2O at the Savannah River Plant, 93% is expended in bringing the concentration from natural abundance to 15% D_2O. Because the quantities of water handled in the higher stages are so small, the advantage of the simplicity and dependability found in less economical processes can be had without appreciable cost penalty. (B.O.G.)

MATHEMATICS AND COMPUTERS

6322 (AFOSR-TN-60-1405) A DERIVATION OF BOLTZMANN EQUATION WITH THE HELP OF AN ASSUMPTION OF DETERMINACY. Technical Report No. 1 [on] THEORETICAL RESEARCH STUDIES OF REACTING PLASMAS. Günther Ludwig (Berlin. Freie Universität. Strahleninstitut). [1960]. 35p. Contract AF61(52)-239.

6323 (MURA-594) CONVERGENCE RATE OF THE NINE-POINT EXTRAPOLATED LIEBMANN ALGORITHM. Harry H. Denman (Midwestern Universities Research Assn., Madison, Wis.). Sept. 18, 1960. 13p. Contract AT(11-1)-384. OTS.

A quadratic equation is developed which determines the optimum value for the over-relaxation parameter α and the value of the corresponding convergence factor A_b^2 for the numerical solution of Laplace's equation in a rectangle, using the nine-point extrapolated Liebmann algorithm. (auth)

6324 (ORNL-2959) A GENERALIZED SORTING SUBROUTINE FOR THE ORACLE. J. H. Vander Sluis and K. L. Vander Sluis (Oak Ridge National Lab., Tenn.). Nov. 28, 1960. 29p. Contract W-7405-eng-26. OTS.

Sorting subroutines that are written in a general form to be easily adapted to a large variety of applications are described. These routines are designed to aid in handling large volumes of data. The routines may be of particular value to spectroscopists. (J.R.D.)

6325 (JPRS-4258) CONFERENCE OF RUMANIAN ACADEMY OF SCIENCES ON ELECTRONIC COMPUTERS. (A Román Népköztársaság Akadémiájának Konferenciája az Elektronikus Számológépekről). Istvan Aczel. Translated from Magyar Tudomány 5, 554-7(1960). 5p. OTS.

Information presented at a conference on computers is outlined. Papers delivered at the conference dealt with electronic computer research, construction and programming, and the use of computers in industry and science. (J.R.D.)

6326 PROGRAMMING FISHER'S EXACT METHOD OF COMPARING TWO PERCENTAGES. W. H. Robertson (Sandia Corp., Albuquerque, N. Mex.). Technometrics 2, 103-7(1960) Feb.

Exact solutions to many statistical problems are now possible through the use of high speed computing equipment. The application of a high speed computer for determining the exact probability statement associated with the problem of comparing two percentages is described. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

6327 (AD-237702) THE MANUFACTURE OF Ti-7Al-12Zr SHEETS. Bi-Monthly Report No. 3 [for] December 31, 1959 to February 29, 1960. W. B. Aufderhaar and S. R. Seagle (Mallory-Sharon Metals Corp., Niles, Ohio). Mar. 1960. 9p. Contract NOa(s) 59-6229-c.

In production processing a 5400-lb ingot of Ti-7 Al-12 Zr was melted and forged to 4- by 16-in. slab. Results of chemical analyses at various positions in the slab, which indicate good uniformity, are tabulated. Results are also included on tensile properties and microstructures. In laboratory work, research work is reported on methods of conditioning aluminum containing titanium alloys to prevent surface contamination, which results in reduction of ductility. (J.R.D.)

6328 (ARF-2187-2) DUCTILE BERYLLIUM ALLOYS. Bimonthly Report No. 2, [Period Covered] November 1-December 31, 1959. Frank A. Crossley and R. J. Van Thyne [Illinois Inst. of Tech., Chicago. Armour Research Foundation]. Jan. 21, 1960. 10p. Contract NOas 60-6036-c.

Liquid-phase sintering is being investigated as a means for producing ductile beryllium. Results of preliminary sinter trials for 75 vol. % beryllium compacts of Be–33Al, Be–31Al–2Ge, and Be–66Ag (compositions are in weight per cent) are reported. Effective wetting was achieved in compacts of the Be–31Al–2Ge and Be–66Ag alloys. The former, sintered 950°C for 1 hr, was reduced 71% by cold pressing before cracking at 90,000 psi. The latter, sintered 1050°C for 1 hr, was reduced 42% before cracking at 77,000 psi. (auth)

6329 (ARF-6043-11) ULTRASONICS AND CERAMIC COATINGS. Quarterly Progress Report No. 2 [for] July 1 to September 30, 1960. W. E. Lawrie (Illinois Inst. of Tech., Chicago. Armour Research Foundation). 23p. Contract AF33(616)-6396.

The objectives of the program are to develop ultrasonic methods of determining ceramic-metal bond strength and uniformity. Promising results were obtained using simple scanning and display systems to detect simulated defects. Two different methods were tried, one using solid specimens with the crystals directly attached and the other using specimens immersed in a liquid couplant with the crystals held in precise parallelism with the specimen surfaces. Equally good results were obtained in either case. Further experiments using surface waves and coatings with lower ultrasonic absorption have indicated that the proposed surface wave technique might be useful for vapor-deposited coatings. The experiments showed that the absorption of ultrasonic energy by ZrO_2 coating prevents the use of surface wave methods. Two simple systems were used to investigate the correlation between logarithmic decrement and bond condition. (W.L.H.)

6330 (CRFD-971) THE COMPATIBILITY OF UO_2 WITH THE REFRACTORY METALS AND REFRACTORY METAL THERMOCOUPLES AT TEMPERATURES ABOVE 1750°C. J. J. Byerley (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Oct. 1960. 27p. (AECL-1126). AECL.

Tungsten, rhenium, tantalum, molybdenum, and niobium were heated in contact with UO_2 at temperatures up to 2660°C. Tungsten and rhenium exhibited no evidence of reaction. UO_2 adhered slightly to molybdenum, tantalum, and niobium; but no attack could be detected. Thermocouples of the five metals were fabricated and tested up to 2200°C with and without UO_2 present in the system. The W–Re, Mo–Re, and Mo–W combinations were found to be the only promising thermocouples. The W–Re thermocouple proved to be the most satisfactory, exhibiting good sensitivity and stability. (auth)

6331 (NDA-2116-6) SPONGE FUEL EVALUATION. Quarterly Technical Report for the Period Ending March 31, 1960. J. M. McKee (Nuclear Development Corp. of America, White Plains, N. Y.). July 15, 1960. 26p. Contract AT(30-1)-2303. OTS.

The first two capsules began irradiation in the MTR on February 1. One was lost immediately due to a conduit leak, but the second is still in the reactor. In-pile thermal conductivity data were obtained on one fuel specimen during the first five weeks of irradiation. The significance of these data is questionable because of anomalies in the capsule calibration data, but the results are quite encouraging. The fuel thermal conductivity appears to be nearly as high as predicted on a mixture basis and has not decreased during 0.12 at. % burn-up. Tests of type-304 stainless steel and niobium as sponge-fuel containers at 1300 and 1800°F, respectively, indicated satisfactory performance for both. Considerable sintering of the uranium occurred at 1800°F (none at 1300°F). Partial separation of sodium and uranium occurred in a sponge-fuel specimen heated above the melting point of uranium for 5 min. Sponge-fuel behavior during meltdown will require further study in later phases of the program. An analysis of thermal-expansion effects in sponge-fuel during temperature transients indicated that fluidization of 15 mil uranium particles would not occur during normal reactor operation. (For preceding period see NDA-2116-5.) (auth)

6332 (NMI-2075) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for February 1959. (Nuclear Metals, Inc., Concord, Mass.). Mar. 30, 1959. Decl. Sept. 1, 1960. 38p. OTS.

Beryllium Metallurgy. The mechanical properties of extruded beryllium-clad U–Zr alloy rods were investigated. Twenty billets of hot-pressed -200 mesh QMV beryllium powder clad in mild steel have been prepared. They will be deformed by rolling at various reductions and temperatures to obtain a random orientation. Beryllium-rich copper alloys have been extruded at a reduction in area of 12 : 1 at 1950°F and then transverse-rolled at a reduction of 5 : 1 at 1850°F to form 0.100-in. thick sheet. An attempt was made to fabricate UBe_{13}, $ZrBe_{13}$, and (U, Zr)Be_{13} by extruding the blended metal powders. Uranium Metallurgy. X-ray diffraction studies were made of the triple β-quenched uranium used as the starting material for extrusions, and of the uranium extruded from it at 485°C. Two attempts at extrusion of the Zr–7% Sn–1.5% Al alloy have failed. The casting of Th–U alloys in graphite molds is reported. Thorium Metallurgy. Thorium alloys are being tested in high-temperature water for the purpose of determining the most corrosion resistant alloy. Zirconium Metallurgy. Corrosion testing of the 12 zirconium base alloys in 900 and 1000°F at 1500 psi is continuing. Other Problems. A study of the shift in the extrusion of tubular aluminum billets is presented. Experiments were conducted to determine recovery and recrystallization temperatures for cold worked yttrium. The extrusion and drawing of yttrium alloy ingots into small tubing is reported. (W.L.H.)

6333 (NMI-2077) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for April 1959. (Nuclear Metals, Inc., Concord, Mass.). June 12, 1959. Decl. Sept. 1, 1960. 31p. OTS.

In beryllium metallurgy, x-ray pure UBe_{13} and $ZrBe_{13}$ were prepared by sintering powder mixtures of uranium and beryllium and zirconium and beryllium at 1400 to 1500°C in an argon atmosphere. The intermetallics were then ground and hot pressed at 4500 psi. $ZrBe_{13}$ machined well; however, UBe_{13} pressing is still being evaluated. Alloys prepared for diffusion couples included Be–10 at.% Cu, Be–2 at.% Fe, and Be–5 at.% Co. In uranium metallurgy, grain size and texture were evaluated for a graphite cast uranium billet (UK-144) containing 990 to 995 ppm silicon. Microstructure and texture examinations are reported, and the texture after γ extrusion is being examined along with grain size. An evaluation was also made of various mold washes for casting Th–U slugs. Four slugs were cast from melt TX-163; these proved to be homogeneous from

top to bottom within 0.1%. The ingots made thus far by arc melting indicate that uranium segregation is a problem. Data relating the wt. % zirconium to corrosion rate are reported for uranium interdiffusion specimens in high-temperature water. Electron probe analysis of the interdiffusion zone was initiated. In cold working of uranium, a method was developed for cold drawing by a preliminary oxidizing technique and an annealing treatment. Techniques for electron-beam welding of end caps to coextruded 2S aluminum-clad uranium fuel tubes are being investigated. Weld cracking is a major problem and may be caused by a stress concentration at the root of the weld bead. To study this several caps were machined with an undercut and are being examined. A program for future development of UC rods is outlined, and a summary of ANL-TREAT diffusion couple information concerning solid-solid uranium interactions with other metals is tabulated. Research is reported in development of a thermite system for ANL-TREAT, and results of thermodynamic calculations are presented for several systems involving beryllium. Samples from four new thorium alloy castings that were Zircaloy-2 extrusion-clad were heat treated at 800 to 850°C for banding studies. Samples of bare-end extrusion-clad alloys were also corrosion tested in 500°F water; results are tabulated. Results of extrusion-clad defected-element water corrosion tests are reported as well as results from band strength tests on coextrusion, Zircaloy-2-clad thorium alloys. In zirconium metallurgy, corrosion testing of 12 ternary zirconium-base alloys in 900 and 1000°F steam is continuing. Results of corrosion testing to date are tabulated. Oxidation experiments to determine the feasibility of hot-working unclad yttrium were conducted; however, the method was not considered desirable because of oxygen gettering. Cold swaging of yttrium is being investigated, and experience in drawing thin-wall tubing is reported. Optimum extrusion temperatures are reported for a series of stainless-steel-clad uranium billets. (J.R.D.)

6334 (NMI-2078) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for May 1959. (Nuclear Metals, Inc., Concord, Mass.). July 13, 1959. Decl. Sept. 1, 1960. 41p. OTS.

Beryllium Metallurgy. Results of chemical analysis of O_2 in beryllium are reported. Diffusion couples were prepared for the analysis of the β beryllium phase boundaries in the alloy systems Be–Cu, Be–Fe, Be–Co, and Be–Nb. Uranium Metallurgy. Gamma and β extrusions were made from the uranium–silicon system for the comparison of textures. An investigation to develop and evaluate arc-melting procedures for producing sound homogeneous thorium–uranium ingots is presented. A program to study the effect of an interdiffusion heat treatment and of subsequent heat treatments upon the corrosion behavior of Zircaloy-2-clad uranium–zirconium specimens containing 7-mil diameter defects extending into the core is reported. A program is presented for cold and warm working of uranium for finishing tube and wire. The apparatus for centrifuging molten uranium within a solid zirconium cladding was put into operation. Work is continuing to develop techniques for making electron beam-welded aluminum end closures on 25 aluminum-clad uranium core fuel tube irradiation samples. The development of procedures for producing sound dense UC rod materials is reported. Thorium Metallurgy. Data are presented on the effect of water temperature on corrosion rate of thorium alloys. Other Problems. Methods of fabricating semi-finished shapes from arc-melted Y billets were investigated. Work was continued on the multi-temperature extrusion process. (W.L.H.)

6335 (NP-9553) METALLURGIE-RAPPORT D'AVANCEMENT, DEUXIEME TRIMESTRE. (Metallurgy Progress Report, Second Quarter). (Brussels. Centre d'Étude de l'Énergie Nucléaire). Sept. 2, 1960. 80p.

BR-1 Fuel Elements. A method is described for welding Iron-Constantan thermocouples to BR-1 fuel elements. Stabilization procedures are given for nonalloyed Belgian uranium, and for stabilization by alloying with niobium–chromium, and molybdenum–zirconium. An experimental study was made of the recrystallization of Belgian uranium. Corrosion of magnesium alloys was studied. Aluminum was investigated as a cladding material. BR-2 Fuel Element. The studies reported include fabrication of aluminum–uranium, casting the "Triplex" element, sandwich lamination, preparation of aluminum/uranium–aluminum/aluminum plates, and nondestructive testing of plates and elements. REBUS Fuel Element. Progress is reported on thermocouple attachment and surface treatment for REBUS fuel elements. Pyrometallurgical Reprocessing. Preliminary work in melt refining is reported. Knowledge of Materials. An extensive tabulation is presented of operating conditions found in the literature for extraction of gases (H_2,N_2,O_2) and from steels, Fe, Al, Be, Cr, Cu, La, Mn, Mo, Ni, Co, Si, Ta, Th, Ti, U, V, W, and Zr. Progress is also briefly reported on hot laboratory materials research and pile irradiation experience. (T.R.H.)

6336 (NP-9658) PROTECTION OF GRAPHITE BY IMPREGNATION. Quarterly Progress Report No. 3 [for] September 1–November 30, 1960. Vitro Job 2195. M. H. Ortner and S. J. Klach (Vitro Labs., West Orange, N. J.). Dec. 15, 1960. 19p. Contract NOw 60-0167-c.

The hypothesis that sample resistivity is the controlling factor in electrokinetic impregnation was substantiated. Experiments show that dense clay-bonded silicon carbide can be impregnated beneath the surface pores whereas only surface pore impregnation is achieved with both dense and porous graphite. The resistivity of the materials differ by a factor of about 10^{10}. Although deep penetration of the substrate by the particles of the coating system is not achieved during deposition, there is evidence of considerable diffusion of the binder-carbide solid solution into the pores of the graphite after sintering. A number of sintered, crack-free, and adherent TaC coatings on ATJ graphite panels were prepared which showed evidence of surface pore penetration. The attainment of satisfactory reproducibility was difficult because of preferential deposition of the binder metal and contamination from erosion of the chrome-manganese steel ball mill. Efforts to prevent contamination by lining the mill with rubber were unsatisfactory. A silicon carbide liner for the mill was ordered and will be received in December. To prevent preferential deposition, precoating of the tantalum carbide particles with nickel by chemical precipitation and electroless nickel plating was investigated. Nickel coatings were obtained by both techniques; however, the chemically precipitated nickel was not adherent when the coated particles were placed in the electrophoretic bath. Good adherence was obtained by electroless plating; but this material, when sintered, cracked during the cooling cycle. Further investigation established that both iron and nickel are required as binders to obtain well-sintered TaC. Work was begun on the preparation of coated rocket nozzle liners for testing at NOL. Graphite nozzles were machined to the WM-D-800-2 configuration, and a cell was designed

for obtaining a uniform electrophoretic deposit. Test coatings were within the required thickness tolerance of ±0.002 in. The coatings, thus far, have cracked at the edge of the nozzle throat during the heat-up cycle. This is believed to result from a temperature differential in the furnace and from improper control of the binder composition. The furnace is being modified to minimize the temperature gradient, and variability in the binder composition will be eliminated when the carbide liner is installed in the ball mill. Thermal shock tests were performed on coated graphite panels. The specimens were plunged into a 2500°C zone, held at temperature for 2 min, and then removed from the hot zone. Microscopic examination of the coating after testing indicated no ill effects. (auth)

6337 (Y-1328) BERYLLIUM CHIP PROCESSING. Z. L. Ardary, W. C. McWhorter, J. W. York, J. E. Perry, F. M. Tench, and P. B. Petretzky (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Dec. 15, 1960. 43p. Contract W-7405-eng-26. OTS.

A process was developed for upgrading beryllium chips contaminated with cutting oils and metallic and nonmetallic trash. Investigations were conducted on grinding of these chips to mesh sizes as low as −200 mesh utilizing attrition milling, fluid energy milling, or planetary ball milling. This entire process adds no significant impurities other than oxygen. The beryllium oxide content of the powders increases no more than 0.50% over that present in the original chip. (auth)

6338 (AEC-tr-4365) RESOLUTIONS OF THE FIRST ALL UNION CONFERENCE. (General Electric Co. Aircraft Nuclear Propulsion Dept.). A translation by J. Woroncow of Chapter 7 of "Redkie Metaly i ikh Splavy." (A publication of the Publishing House of Literature on Metallurgy, Moscow, 1960). (XDC-60-11-5) JCL or LC.

This article outlines general trends of the Soviet program on rare metals and alloys, as recommended by the First All Union Conference on Rare Metals and Alloys. (auth)

6339 (CEA-tr-A-785) MÉTHODE D'ATTAQUE MÉTALLOGRAPHIQUE PERMETTANT DE DISTINGUER LES ACIERS AU CHROME–METAL RÉSISTANTS AUX AGENTS CHIMIQUES, DES ACIERS AU CHROME–NICKEL–MOLYBDÈNE. (Method of Metallographic Etching for Distinguishing Chrome Steels Resistant to Chemical Agents and Chromium–Molybdenum–Nickel Steels). F. K. Naumann and W. Carius. Translated into French from Arch. Eisenhüttenw. 28, 641-4(1957). 6p.

Etching of chrome steel and Cr–Mo–Ni by $HCl-H_2SO_4$ with a $K_4Fe(CN)_6$ or $K_3Fe(CN)_6$ indicator is briefly described. (T.R.H.)

6340 (CEA-tr-R-979) PASSIVATION DES MÉTAUX. (Passivation of Metals). Ya. (Ia.) M. Kolotyrkin and G. M. Florianovich. Translated into French from Khim. Nauka i Prom. 3, 483-91(1958). 34p.

A generalization and analysis are presented of the research results obtained on corrosion in the last 10 years. The discussion is divided into sections on: Passivation of Active Metals in Acid and Neutral Solutions, Justification of Experimental Laws, Activation of Passive Metals, and Explanation of Curves of Potential Drop after Interruption of the Current. (82 references). (T.R.H.)

Corrosion

6341 (HW-67098) AQUEOUS CORROSION OF ALUMINUM–PLUTONIUM ALLOYS. C. H. Bloomster and Y. B. Katayama (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 12, 1960. 18p. Contract AT(45-1)-1350.

An aluminum-plutonium alloy with high temperature aqueous corrosion resistance is required for spike enrichment of the Plutonium Recycle Test Reactor (PRTR). A decision was made to investigate Al-Ni-Pu alloys and Al-Si-Pu alloys with lower silicon content in search for a more satisfactory corrosion resistant alloy than eutectic AlSi-Pu. The preparation, fabrication, and testing of these alloys are described. Five Al-Pu alloys had good high-temperature aqueous corrosion resistance when tested in a static autoclave for 24 hr at 350°C and 2500 psi. The compositions are given. Corrosion testing was continued to 100 hr on some of the alloys, which established corrosion rates of 2 mils per month. The corrosion rates of the latter three alloys did not differ substantially, so that the addition of nickel above 2% is unnecessary. The Al-1.3 wt.% Ni-1 wt.% Si-2 wt.% Pu alloy was structure sensitive and required a fine uniform dispersion of the second phase in order to obtain consistent corrosion resistance. Based on the lower nickel and silicon contents the Al-Ni-Si-Pu quaternary alloy was selected for the PRTR spike charge. Over 2000 lb of this alloy were cast for fabrication into fuel elements for physics tests. However, difficulties in chemically reprocessing the fuel with this level of silicon content precluded irradiation. Therefore, for power operation of the PRTR, the alloy composition selected was Al-2 wt.% Ni-1.8 wt.% Pu (Si was held to 0.3 max.). One thousand pounds of this alloy have been cast for fuel element fabrication. (auth)

6342 (ORNL-2338) INTERIM REPORT ON CORROSION BY ZIRCONIUM-BASE FLUORIDES. G. M. Adamson, R. S. Crouse, and W. D. Manly (Oak Ridge National Lab., Tenn.). Jan. 17, 1961. 60p. Contract W-7405-eng-26.

The zirconium fluoride-base fluoride mixture $NaF-ZrF_4-UF_4$ (50–46–4 mole %), referred to as "fluoride 30," was circulated in Inconel thermal convection loops for periods varying from 500 to 5000 hr and at a hot-leg temperature of 1500°F. The purpose of this program was to develop an understanding of the corrosion mechanism accompanying the circulation of zirconium fluoride-base mixtures in Inconel. The attack in the Inconel loops was in the form of subsurface voids formed by selective leaching of chromium from the alloy. After 500 hr of operation, the voids were found to depths of about 10 mils, with the depth continuing to increase at a rate of about 4 mils per 1000 hr of operation. The effects of such variables as time, hot-leg temperature, temperature drop, fluoride purity, loop size and shape, and inhibitors on the depth of corrosion were studied. It was found that the attack was reduced when a portion of the uranium was present in the trivalent state, but the results were not reproducible. A few tests also were carried out in loops constructed from nickel, stainless steels, iron, Hastelloy B, molybdenum, and niobium. A limited amount of work was done on Inconel loops circulating alkali metal-base mixtures (NaF, LiF, KF, UF_4) with portions of the uranium in the trivalent state. Reduced attacks were found, but disproportionation and production problems require additional study. (auth)

6343 CORROSION-EROSION OF SENSITIZED AISI TYPE 304 STAINLESS STEEL IN A THORIUM DIOXIDE–URANIUM TRIOXIDE SLURRY. D. C. Vreeland (United States Steel Corp., Applied Research Lab., Monroeville, Penna.). Corrosion 17, 21t-4t(1961) Jan.

Corrosion test loops were employed in evaluating the corrosion-erosion of sensitized AISI Type 304 stainless

steel in a thorium dioxide–uranium trioxide slurry. It was found that sensitized, nonpickled Type 304 stainless steel was not attacked intergranularly and exhibited about the same corrosion rate as as-received Type 304. Type 304 stainless steel, sensitized and pickled, was attacked at appreciably higher rates than as-received Type 304 or than sensitized, nonpickled Type 304; however, when a layer of metal which had been corroded intergranularly by the pickling solution was removed by the action of the slurry, the attack by the slurry diminished. (auth)

6344 CORROSION RESISTANCE OF DENSE, IMPERMEABLE SILICON CARBIDE. Roy E. Dial and G. E. Mangsen (Carborundum Co., Niagara Falls, N. Y.). Corrosion 17, 35t-8t(1961) Jan.

Corrosion data are presented for dense, impermeable silicon carbide in various media. Results are given for static corrosion tests in aqueous solutions of acids, alkalies, and salts; in fused salts and molten metals up to 900°C; and in gases up to 1000°C. The corrosion resistance of the material was found to be good in most acid solutions and poor in strong alkalies. The resistance in fused salts, molten metals and gases varied with the corroding medium. (auth)

6345 STRUCTURAL CHANGES AND CORROSION RESISTANCE OF THE Cr17Ni2 TYPE STEELS. A. P. Akshentseva (Scientific Research Inst. of Chemical Equipment, [USSR]). Metalloved. i Termichesk. Obrabotka Metal. No. 11, 7-12(1960) Nov. (In Russian)

Although ferritic-martensitic acid resistant stainless steels can be welded satisfactorily, the region next to the weldment has a lowered corrosion resistance in view of the structural changes caused by the heating. Investigation showed that such a localized overheating followed by cooling in air results in the formation of a martensitic structure with a microhardness of 545 to 649 kg/mm^2 under considerable reduction of the tensile strength. During annealing at 300 to 600°C, martensite and chromium carbide phases precipitate out, resulting in an impoverishment of the alloy in chromium, and yielding an annealed martensite with a reduced corrosion resistance. After annealing at 400 to 650°C, the intercrystalline corrosion becomes selective, attacking preferentially the martensite rather than the chromium-containing ferrite. At 680 to 700°C the martensite is completely decomposed into a mixture of ferrite and carbide, precipitating a stable chromium carbide on the grain boundaries. After further heating up to 1300°C, exposure to the corroding medium of $CuSO_4$ + H_2SO_4 results in intercrystalline corrosion. If austenitic electrodes are used for the arc welding, the welded goods must be annealed at 680 to 700° for 1 hr. (TTT)

6346 PROTECTION OF PERLITIC STEELS AGAINST HIGH-TEMPERATURE GASEOUS CORROSION. A. V. Ryabchenkov and V. I. Velemitsina (Central Scientific Research Inst. of Heavy Machinery, USSR). Metalloved. i Termichesk. Obrabotka Metal. No. 11, 39-42(1960) Nov. (In Russian)

Heat-resistant steels were coated with nickel by chemical deposition at 90 to 92°C from a solution containing 21 g/l $NiCl_2$, 24 g/l sodium hypophosphate, and 10 g/l sodium acetate at a pH of 4.8 to 5.3. Chemical analysis of the nickel layer indicated that it contained 7.5 to 9% nickel. The coated specimens were heat treated at 400°C for 1 hr in order to improve the adherence of the layer. High temperature testing was performed at 650°C in air and in superheated steam, using weight gain data for determining the corrosion resistance of the layer. It was found that after the high-temperature exposure, the layer consisted of a solid solution of phosphorus in nickel, including the excess in the form of a Ni_3P phase. Even after prolonged heating (1000 hr) in air and steam, the nickel layer under the newly formed oxide film retained a satisfactory hardness, making possible the use of this method for goods exposed to high friction and elevated temperatures during their service life. It is concluded that the chemically deposited nickel coating protects satisfactorily low-alloy perlitic steels against high-temperature corrosion by steam and air. (TTT)

6347 GALVANIC-CORROSION OF TITANIUM COUPLED WITH STAINLESS STEEL. Zenichiro Takao, Koichi Nakano, and Akira Takamura. Nippon Kinzoku Gakkaishi 24, No. 6, 380-3(1960). (In Japanese and English)

The galvanic corrosion of commercially pure titanium coupled with 18.8 stainless steel was studied in various kinds of corrosive media. In reducing acids, although the corrosion potential of titanium itself was in the active range and less noble than that of stainless steel, it was shifted into the passive range by coupling with stainless steel. Thus titanium was anodically protected and its corrosion rate decreased remarkably, whereas the corrosion rate of stainless steel remained unchanged. For instance, titanium and stainless-steel couples were perfectly resistant in 10% hydrochloric acid, 10% sulfuric acid, and 10% oxalic acid solutions at room temperature, in which uncoupled titanium was corroded. This phenomenon of anodic protection was also observed in boiling 1% hydrochloric acid, 1% sulfuric acid, and 0.5% oxalic acid solutions. In oxidizing acids, such as nitric acid, the galvanic corrosion was negligible because the potentials of titanium and stainless steel were in their own passive ranges, and that of the couple was also in the passive range of both metals. In the case of boiling 99% acetic acid, no galvanic corrosion was observed, either. In neutral chloride solutions, such as 3% sodium chloride solution, the potential of couple fluctuated and the direction of galvanic current changed irregularly because of the instability of protective film on stainless steel. However, the galvanic current was always less than 1 μ A/cm^2, so that the galvanic corrosion was also negligible. (auth)

6348 PROCESS FOR PROTECTING MAGNESIUM AND ITS ALLOYS FROM OXIDATION. (to Commissariat à l'Énergie Atomique). British Patent 852,238. Oct. 26, 1960.

A simple method for protecting magnesium and its alloys from oxidation at temperatures above 350°C is presented which consists of introducing a small amount of a fluorine compound into the atmosphere so that a fluorine concentration of $\geq 2\gamma$ per liter of atmosphere results. The effect of the fluorine is to form a protective MgF_2 layer on the metal surface. Fluorine compounds which may be used are HF, trifluoromethyl benzene, and halogenated hydrocarbons containing one or more fluorine atoms such as Freon. Various methods are described for introducing the fluorine compound into the air. In this way, magnesium and its alloys may be heated up to 500°C for several hundred hours in an oxidizing atmosphere, even with moisture present. If the metal treated in the above way is subsequently heated in an oxidizing atmosphere with no fluorine compound, the protection continues for several hundred more hours. Three examples of the method are given. (D.L.C.)

Fabrication

6349 (AD-227423) LEAD SHIELDING. Interim Report No. 1 [for period] June 30, 1958–June 30, 1959.

(Storchheim Research and Development Corp., Woodside, N. Y.). Sept. 1, 1959. 38p. Contract NOas 59-6249-c.

The program undertaken involves the development of direct powder rolling techniques for the fabrication of high-strength lead strip for use as a radiation shielding material and subsequent production of strip at a pilot-plant level. The properties of strip produced from different grades of powders were investigated. Factors such as rolling speed, roll opening, and lubrication were examined. Significant increases in ultimate tensile strength and ductility were obtained. From the experiments done so far, it can be said that roll opening during rolling has a bearing on mechanical characteristics of the strip produced. The effect of mesh fraction and oxygen content of the material was also studied. Most of the data obtained were on Glidden 40B grade and 200B grade lead powders. Procedures for the control tests on powders to be used for rolling have been established and also a manual for rolling of powders is set up. (See also AD-237798.) (auth)

6350 (AD-237797) LEAD SHIELDING. Interim Report No. 4 [for period] June 30, 1959–June 30, 1960. (Storchheim Research and Development Corp., Woodside, N. Y.). 43p. Contract NOas 59-6249-c.

Data are included on an evaluation of the results obtained by direct rolling of lead powders, fibers, and ribbon into continuous strip. The feasibility of producing high-strength thick plate from lead powders was also demonstrated. Through direct powder rolling, a good correlation was obtained between the surface area to volume ratio of various lead powders and fibers and the mechanical properties of the powder or fiber fabricated strip. The effect of cold reduction and heat treatment on the mechanical properties of powder fabricated strip was studied and stress-rupture, creep, x-ray diffraction, and tensile studies were continued. It appeared that the excellent properties of the powder rolled product could be further improved by controlled cold working and annealing. (See also AD-237798.) (auth)

6351 (ANL-6141) THE DRIP CASTING OF ZIRCONIUM METAL. Work Completed: March 1951. R. J. Dunworth and R. E. Macherey (Argonne National Lab., Ill.). Feb. 1960. 18p. Contract W-31-109-eng-38. OTS.

A drip casting process initiated to obtain zirconium castings uncontaminated by the melting process and to remove volatile impurities from the zirconium feed rod is described. A feed rod of zirconium is held above the mold, and the bottom of the rod is melted rapidly off into a mold to produce the casting. The melting process is carried out under high vacuum, so that very little atmospheric contamination can result, and some removal of volatile impurities is possible. Since no crucible is used to contain the molten metal, no contamination can result from this source. (auth)

6352 (CF-60-6-72) ORNL FUEL CYCLE PROGRESS REPORT FOR PERIOD MARCH 15 to MAY 15, 1960. D. E. Ferguson (Oak Ridge National Lab., Tenn.). June 10, 1960. 4p. OTS.

A method for the preparation of high-density ThO_2 of the correct particle size for vibratory compaction is under development. The method being developed appears easily adaptable to remote operation. Pure ThO_2 made by this method was readily compacted to 86% of theoretical density by pneumatic vibration. Preparations of high-density mixed ThO_2–UO_2 and UO_2 by this general method have been successfully carried out. Densification of arc-fused mixed oxide by a pneumatic vibrator compared favorably with results of tests with the same oxide using electronic vibrators at both Huntsville, Alabama, and Savannah River. In the limited tests with the electronic vibrators at the other sites, it appeared that a saw-tooth wave shape gave greater densification than a sine wave or random noise. (auth)

6353 (DMIC-139) MELTING AND CASTING OF THE REFRACTORY METALS MOLYBDENUM, COLUMBIUM, TANTALUM, AND TUNGSTEN. W. H. Johnson (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 18, 1960. 34p. Contract AF18(600)-1375. (PB-151098).

The technology of melting and casting refractory metals is considered from the standpoint of ingots and shaped castings. The production of ingots is more advanced than is the production of shaped castings. Molybdenum and niobium were centrifugally cast with some success. Shaped castings of tantalum were produced experimentally. No satisfactory method for the production of shaped tungsten castings is presently available. There is an indicated need for shaped castings of the refractory metals, and further development work appears to be justified. The cold-crucible induction furnace, presently under development for titanium, might be adapted for the refractory metals. (auth)

6354 (HW-66575) EVALUATION OF WELDED AND SEAMLESS ZIRCONIUM AND ZIRCALOY-2 TUBING. Final Report. S. H. Bush (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1, 1960. 31p. Contract AT(45-1)-1350. OTS.

Work on the evaluation of zirconium and Zircaloy-2 tubing fabricated by welding or extrusion is reviewed. It was concluded that a satisfactory method of fabrication exists for producing most sizes of seamless tubing investigated; it also was concluded that substantial improvement is necessary in the welding operation to minimize contamination and improve yields of welded tubing. Seamless tubing appears more nearly to meet reactor requirements, based on the tests conducted and on a logical extrapolation of improvement in fabrication technology. (J.R.D.)

6355 (HW-SA-2048) ANNEALING OF COLD WORKED ZIRCONIUM (thesis). Daryl Leslee Gray ([General Electric Co. Hanford Atomic Products Operation, Richland, Wash.]). 1959. 53p. OTS.

The fabrication and heat treatment of zirconium and the mechanisms of recovery, recrystallization, and grain growth in this metal were studied. A literature survey, a description of procedures used, a summary and list of conclusions, and illustrations of microstructures are also presented. (J.R.D.)

6356 (JEN-80-DMe/I5) ACEROS AL BORO. PARTE I. PREPARACIÓN. (Boron Steel. Part I. Preparation). Jaraiz Franco E. and Esteban Hernandez J. A. (Spain. Junta de Energía Nuclear, Madrid). 1960. 16p.

With the advent of the first nuclear reactors the need arises for control rods and shielding for some types of radiations. One of the materials used for this purpose has been high boron steel. Melting and casting procedures used for the production, at laboratory scale, of steels with boron content ranging from 1 to 4 per cent, and the metallographic and x-ray techniques used for the identification of the present phases are described. The electrolytic technique used for the isolation of the Fe_2B phase and its subsequent x-ray identification proved to be satisfactory. Forging conditions are discussed. (auth)

6357 (NAA-SR-5591) KINETICS OF HOT PRESSING. J. D. McClelland (Atomics International. Div. of North

American Aviation, Inc., Canoga Park, Calif.). Jan. 1, 1961. 21p. Contract AT-11-1-GEN-8. OTS.

Hot pressing of powdered materials can be described adequately by using a plastic flow theory proposed by Mackenzie and Shuttleworth for sintering. The present derivation assumes that the principal driving force for the closing of pores is the applied hydrostatic pressure instead of the surface tension of the pores. This pressure term, when corrected for the density of the compact, can be substituted for the surface tension term in the original derivation. The resultant equations give the material densification rate in terms of a yield point and a viscosity. The equations predict that an end-point density dependent upon the applied pressure and the yield point of the material will be reached. The effect of temperature and pressure on the rate of beryllia powder compacts was obtained experimentally. The pressures ranged from 1000 to 2000 psi, the temperatures from 1200 to 1700°C, and the time from 15 to 240 min. The curves show a steep initial rate of densification followed by a gradual approach to a nearly asymptotic end-point density. The theoretical equations are found to describe successfully the densification rates observed in beryllia when reasonable values of the yield point and viscosity are assumed. (auth)

6358 (SEP-175) INVESTIGATIONS ON STAINLESS STEEL–UO_2 FUEL ELEMENT CORE MATERIAL. S. I. Megeff and H. S. Kalish (Sylvania Electric Products Inc. Atomic Energy Div., Bayside, N. Y.). Aug. 12, 1955. Decl. June 9, 1960. 27p. For Pratt and Whitney Aircraft Div., United Aircraft Corp. Contract AT(11-1)-229. OTS.

Methods for making 30 wt. % UO_2–stainless steel core material of the highest possible density were investigated. Type 310 and type 347 stainless steel was utilized as the matrix because of the corrosion resistance of these materials to supercritical water. It was found that, because the presence of niobium increased the densification rate during sintering, type 347 was ordinarily superior to type 310, but that this faster sintering rate could also be achieved by adding niobium to the type 310 stainless steel. Firing UO_2 in a hydrogen atmosphere, the dew point of which was not critical, for at least 3 hr at a temperature of 1300°C or higher, resulted in a suitable UO_2 for making core material. If high density is the main consideration, grinding of the UO_2 to average particle size of about 2 μ was found to give the best results. The sintering of core material must be carried out in a dry hydrogen atmosphere (dew point better than −50°C). If a sintering cycle of 16 hr at 1300°C is utilized, core material with a uniform oxide distribution and density of 95% of theoretical can be obtained. Coining was found to have little benefit on the final density. Good plates of electroless as well as electrolytic nickel were placed on 30 wt. % UO_2–stainless steel core material. After plating, hydrogen firing resulted in a dense, pore-free plate with a diffusion bond between the plate and the base stainless steel matrix. (auth)

6359 (CEA-tr-R-992) MÉTHODE DE CALCUL DES ZONES DE TEMPÉRATURES DE LA SOUDURE À L'ARC EN ATMOSPHÈRE D'ARGON DES LAMES EN DURALUMIN D. 16. (Method for Calculating Temperature Zones in Argon–Atmosphere Arc Welding of Sheets of Duralumin D. 16.). I. N. Artem'eva (Artemieva). Translated into French from Svarochnoe Proizvodstvo No. 5, 16-19(1958). 16p.

A study was made of the temperature distribution in duralumin D near an arc weld in order to calculate the temperature zones and establish temperature limits for proper welding. The calculations include a consideration for the cooling by the argon jet. Contraction of the arc and the blast of the argon jet lessen the scattering of the W-Al arc. The temperature limit for a concentrated source during welding of duralumin is 500 to 550°C. The dimensions of the pieces of aluminum that can be welded are much greater than those for steel because of the greater thermal conductivity. (T.R.H.)

6360 (CEA-tr-X-221) ETUDE DES ALLIAGES SPÉCIAUX DE MAGNÉSIUM OBTENUS PAR COULÉE. III. APTITUDE À LA COULÉE (" CASTABILITY"). (Study of the Special Alloys of Magnesium Obtained by Casting. III. Suitability for Casting). M[akoto] Tsukuda. Translated into French by S. S. Minn from Keikinzoku 9, No. 36, 45-52(1959). 27p.

An investigation was made of the differences in castability of special and ordinary magnesium alloys. The depth of the shrinkage pipe is greater for the special alloys than for the AZ series of alloys. This is especially true for alloys of magnesium with the rare earths. The addition of zirconium causes an appreciable improvement. Addition of zinc causes even greater improvement. Measurements of linear shrinkage were made for pieces cast and molded in sand. The measurement was the sum of shrinkage for the liquid-solid transformation and the shrinkage upon cooling. The shrinkage of special magnesium alloys is greater than that of AZ alloys. It is greater for Mg–Zr–rare earth than for Mg–Zn–Zr–rare earth. Mg–Zn–Zr has a smaller shrinkage. It is thus necessary to vary the clearance of the mold in wood or metal as well as the alloy composition. The hot shortness is caused by shrinkage and by a decrease in malleability during cooling. The hot shortness is very great for the special magnesium alloys and particularly for Mg–Zr–rare earths. A marked segregation of zirconium occurs when the piece is large and the rate of cooling is not uniform. (T.R.H.)

6361 ARC WELDING OF A Ni–Cr–Fe (INCONEL) ALLOY FOR NUCLEAR POWER PLANTS. Jay Bland and W. A. Owczarski (General Electric Co., Schenectady, N. Y.). Welding J. (N. Y.) 40, 22-s-32-s(1961) Jan.

An investigation was made of the arc welding of Inconel, using commercially available filler metals and the shielded-metal-arc, inert-gas tungsten-arc, and inert-gas metal-arc welding processes. Weldments meeting the high-quality standards required for nuclear power plant service can be made with all of the filler metals and processes studied. In general, all structural welds of Inconel to itself, to Type 304 stainless steel, or to carbon steel failed in the weaker base metal when tested for static tensile properties. All-weld-metal mechanical properties of the Inconel-type filler metals exceeded those of the annealed wrought base metal. Covered electrodes for welding Inconel exhibited somewhat more difficult usabilities than did the standard stainless-steel electrodes. Inconel-type filler metals were modified by additions of niobium, Nb-Mn, or titanium for specific applications. Both the niobium- and titanium-modified filler metals, when welding with the shielded metal arc or the inert-gas metal-arc welding processes, produced deposits which exhibit fissures of various sizes, depending on several factors. The bare wire filler metals, used with the manual inert-gas tungsten-arc welding process, usually produced fissure-free deposits. These fissures, which were detected in metallographic examination and in bend tests, were intergranular and appeared to be caused by the segregation of some low strength phase during solidification of the weld deposits.

The Nb-Mn modified electrodes deposit weld metal essentially free from porosity and fissures. Weld deposited overlays made with the Inconel-type filler metals on carbon steel exhibited bend properties comparable to those of structural butt weld deposits. Iron dilution of the alloy deposit varied with technique and/or process used. (auth)

6362 WELDING. Supplement to CTR's 324-331. OTS Selective Bibliography. Office of Technical Services, Washington, D. C. Mar. 1960. 14p. (SB-402). $0.10(OTS).

A bibliography on welding techniques and equipment listed in the two OTS abstract journals U. S. Government Research Reports and Technical Translations is presented. 270 references. (J.R.D.)

6363 METHOD OF HOT WORKING A METAL BILLET. (to Babcock & Wilcox Co.). British Patent 851,948. Oct. 19, 1960.

A method for hot working zirconium-clad U–10% Mo alloy for reactor fuel elements is described in which oxidation of the cladding and galling of the extruding apparatus are prevented. This prevention is accomplished by fitting a carbon steel jacket around the billet, heating to 1600°F to form a bond-inhibiting oxide film between the jacket and billet, and hermetically encasing the billet in the jacket to form a slug. The extrusion is then carried out with a vertical extrusion press described in Patent Serial No. 851,949, the slug being heated by induction to 1800°F just prior to extrusion. After extrusion, the jacket is removed either mechanically or by pickling in 20% H_2SO_4. (D.L.C.)

6364 IMPROVEMENTS IN APPARATUS FOR EXTRUDING A METAL BILLET. (to Babcock & Wilcox Co.). British Patent 851,949. Oct. 19, 1960.

A vertical extrusion press is designed for hot working zirconium-clad U–10% Mo alloy billets for reactor fuel elements as described in Patent No. 851,948. The press includes a ram to force the billet from a container through the orifice of an extrusion die and induction heating coils positioned just outside the container to heat the billet before extrusion. The advantage of this press is that its parts remain cool as compared with extrusion methods in which the billet is heated separately in a furnace. (D.L.C.)

6365 METHOD OF INCREASING THE DISPERSIBILITY OF SLURRY PARTICLES. (to U. S. Atomic Energy Commission). British Patent 851,983. Oct. 19, 1960.

A method for treating thorium oxide particles and other refractory metal oxide particles (titanium, uranium, zirconium, and magnesium) for increased dispersibility in aqueous slurries is outlined in which the oxide particles are coated with an organo-silicon compound and then fired at 600 to 1200°C to decompose the compound, leaving silica bonded to the particles. A preferred organo-silicon compound is G.E. Dryfilm SC-77 which may be deposited on the oxide particles via the vapor phase, although others, including ammonium silicon compounds, can be used. If the thorium oxide slurries are to be used in a reactor, the chloride content resulting from the method must be removed. Data are presented for the effects of silica coatings at various firing temperatures on thorium oxide particle dimensions and slurry properties together with an example of the method in which thorium oxide is exposed to the vapors of a dimethyldichlorosilane-methyltrichlorosilane mixture and then fired, the consequent chloride contamination being removed by NH_3 and water washing. (D.L.C.)

6366 HIGH ENERGY RADIATION METHOD FOR PRODUCTION OF CELLULAR MATERIALS. Fred Berry Waddington (to Metropolitan-Vickers Electrical Co., Ltd.). British Patent 853,191. Nov. 2, 1960.

Cellular materials, usually made by adding a blowing agent to a material and heating to expand the material, can more easily be produced by using high-energy radiation in place of heat to decompose the blowing agent. In this way, heat damage to the material is avoided, the gas evolution rate is more readily controlled, and the properties of the material are often enhanced by the irradiation. Materials which may be expanded in this way include natural and synthetic rubber and vinyl monomers; suitable blowing agents are benzoyl peroxide, azocyclohexanoic dinitrile, and α, α'-azodiisobutyronitrile (Genitron AZDN). An example of this method is given in which Genitron AZDN is milled into a natural rubber and the mixture exposed to 4-Mev electrons at a dose rate of 1 Mrad/min to a total dose of 30 Mrad. (D.L.C.)

6367 PROTECTION OF URANIUM. Asher Angel Hyatt (to British Thomson-Houston Co., Ltd.). British Patent 853,302. Nov. 2, 1960.

The reactor fuel element comprising uranium clad with aluminum can be improved by providing an interlayer between the uranium and the cladding, thereby circumventing the tendency of these two metals to form intermetallic compounds above 400°C. Such an interlayer consists of a niobium coating on the aluminum side and a 0.001-in. thick nickel coating on the uranium side. In one preferred method of fabrication, $NbCl_5$ and H_2 gases are passed over the nickel-coated uranium whereby niobium is deposited on the nickel. (D.L.C.)

6368 METHOD OF MAKING COMPOSITE FUEL ELEMENTS. (to U. S. Atomic Energy Commission). British Patent 853,394. Nov. 9, 1960.

A method for joining the sections of a composite fuel blanket element for a fast breeder reactor and for capping the ends of a fuel element consisting of a uranium rod clad in Zircaloy-2 is outlined in which the exposed uranium is etched to the depth of $\sim 1/10$ mil, a thin disk of zirconium is placed between the ends to be joined, pressure is applied to the joint, the joint is welded with an inert gas-shielded arc to fuse the cladding to 50% of its thickness, and the joint is heated by induction to form a diffusion bond between the uranium and the zirconium disc. A specific example of this method and welding conditions is presented. (D.L.C.)

6369 RADIOACTIVE BEADS. (to Chininfabrik Braunschweig Buchler & Co.). British Patent 854,825. Nov. 23, 1960.

A radioactive bead with a central bore may be fabricated comprising an inactive solid body with a recess for the radiation source, the recess being closed after the source is introduced. Procedures are given for fabricating variants of this type of bead together with 24 drawings. (D.L.C.)

Properties and Structure

6370 (AD-217515) FABRICATION OF BERYLLIUM WIRE. Progress Report No. 3 [for] February 16 to April 16, 1959. Technical Report No. 150. A. G. Gross, Jr., R. G. O'Rourke, and W. W. Beaver (Brush Beryllium Co., Cleveland). 48p. Contract N. O. as 59-6030-C.

True-stress true-strain tensile properties below 800°F

were investigated. The results indicated reproducible ductile behavior as low as 750°F, allowing the use of lower working temperatures, which should favor more efficient lubrication in the drawing die. Several fixturing improvements were made for use on the draw-bench. Drawing experiments produced rod at 0.144-in. diameter (drawn from 0.252-in. diameter), a quantitative evaluation of molybdenum disulfide plus powdered graphite for lubrication, pointing techniques, and a cleaning technique. These experiments also proved certain procedures unacceptable. Tensile testing of drawn stock substantiated the basic applicability of the Power Law of Strain Hardening. Metallographic and x ray studies showed the development of crystal arrangements quite similar to those found in extruded beryllium. Initial heat-treating experiments provided an optimistic suggestion of control of mechanical properties through thermal treatment after drawing. (For preceding period see AD-215613.) (auth)

6371 (AD-241213) RESEARCH STUDY FOR DEVELOPMENT OF ALUMINUM BASE ALLOYS BY POWDER METALLURGY TECHNIQUES. Interim Project Report for the Contract Period March 1, 1959 through February 29, 1960. S. G. Roberts (Kaiser Aluminum and Chemical Corp., Spokane). Aug. 12, 1960. 79p. Project No. 04920. Contract DA-04-200-507-ORD-886. (MS-PR-60-41).

A laboratory scale study was conducted to determine the properties of wrought aluminum-base alloys fabricated by the extrusion of prealloyed powders. A comparison was made of the properties and characteristics of extrusions prepared from prealloyed powders and small billets of conventional wrought plate of both work-hardening (3003 and 5083) and precipitation-hardening (2024 and 7075) alloys. An exploratory survey of alloy compositions was conducted in the Al–Mn, Al–Mg, and Al–Zn–Mg–Cu alloy system. In the Al–Mn alloy system Mg, Zr, and Zr–Ti–V additions were made to base alloys containing between 2.5 and 7.5% Mn. The results indicated that further alloy development might well yield aluminum-base alloys of highly unique combinations of properties. In the Al–Mg system, the effect of relatively large additions of such elements as Cr, Mn, and Fe were determined at Mg levels of 5.75, 7.5, and 10%. In some instances it appeared that the upper alloy limit of the powder metallurgy approach was exceeded. A series of Al–Zn–Mg–Cu alloys in which various zinc and magnesium additions were made to an essentially Al–2.0% Cu-base alloy was evaluated. (W.L.H.)

6372 (ARF-2191-2) IMPROVED VANADIUM-BASE ALLOYS. Bimonthly Report No. 2, [Period Covered] February 1–March 31, 1960. B. R. Rajala and R. J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Apr. 26, 1960. 10p. Contract NOas 60-6056-c. (AD-238501)

Promising V-Ti (Nb, Mo, Ta, W) alloys are being investigated since vanadium-base alloys exhibit excellent elevated temperature strength. Fabrication of the arc-cast "pancake" ingots to 0.050 in. thick sheet was performed by cold rolling. Only one intermediate anneal was required for the V–5 wt. % Ti–20 wt. % Nb composition. Tensile testing was conducted at room temperature and 2000°F. Specimens were protected by an inert atmosphere at elevated temperatures to protect against oxidation. Several V–Zr–Nb and V–Hf–Nb alloys were evaluated, but results to date do not show improvement over the V–Ti–Nb system. The V–60 wt. % Nb alloy exhibits a tensile strength of 63,500 psi at 2000°F. (auth)

6373 (ARF-2200-6) THE BORON–CARBON SYSTEM. Quarterly Report No. 2 [for] August 1, 1960 - October 31, 1960. Rodney P. Elliott and Ray J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Nov. 8, 1960. 11p. Contract AT(11-1)-578, Project Agreement No. 4. OTS.

A definitive investigation of the boron–carbon equilibrium system is being made by x-ray-diffraction, metallographic, and thermal analytical techniques. Additional boron–carbon alloys were prepared by sintering and arc-melting compacts prepared from boron and high-purity graphite. Metallographic examinations of these alloys are in agreement with alloys previously prepared from lampblack. X-ray investigation of sintered compacts indicates that the solubility range of boron carbide extends almost to pure boron. Boron of various purities was annealed for times up to 4 hr, but no structure other than β-rhombohedral has been detected. Very high purity boron (10 ppm impurity) was obtained for the study of allotropy and the equilibrium relationships at very dilute carbon contents. (For preceding period see ARF-2200-3.) (auth)

6374 (ARL-TR-60-272) TEMPERATURE DEPENDENCE OF PLASTIC YIELD STRESS IN MAGNESIUM OXIDE SINGLE CRYSTALS. J. E. May and M. L. Kronberg (General Electric Co. Research Lab., Schenectady, N. Y.). Apr. 20, 1960. 26p. Project No. 7022. Contract AF33 (616)-5511.

The temperature dependence of the plastic yield stress of cleavage slabs of Norton Company magnesium oxide, containing approximately 0.2% impurity, has been investigated up to 1000°C for bending under three-point loading. Prior thermal history has been found to be an important variable. In particular, annealing followed by a rapid quench produces a marked softening, and at the same time causes a homogenization of the starting material. Such samples have displayed inflections in strength vs. temperature, corresponding to a minimum in the vicinity of 500°C followed by a maximum at around 700°C. At temperatures above those associated with the inflections, the samples show pronounced yield-point barriers, and subsequent deformation occurs by jerky flow. The various observations have been discussed in terms of the interactions of dislocations with impurities that may be in precipitate or solution form, depending on past history and conditions at the time of testing. In particular, interpretation is based on conventional precipitation hardening and solution softening mechanisms commonly known for metals, as well as in terms of the related concepts of the charges on ionic dislocations with surrounding charged ion vacancy clouds, as they are affected by solution impurities. (auth)

6375 (ARL-TR-60-288) RESEARCH ON DISPERSION HARDENING. Period [covered]: May 15, 1959 to May 15, 1960. R. W. Guard (General Electric Co. Research Lab., Schenectady, N. Y.). June 24, 1960. 35p. Project No. 7021. Contract AF33(616)-6406.

In order to understand the mechanism by which second-phase particles strengthen alloys, it is necessary to know the nature of the interaction of slip lines and dislocations with the particles. The observations described in this report indicate that the slip bands formed in nickel are the result of much cross slip and suggest that particles interfere with the long-range motion of loops and thereby reduce the amount of cross slip. No evidence of the nature of the mode of slip line-particle interaction was obtained. Studies of the temperature dependence of the flow stress in single-phase and two-phase alloys give indirect evidence that

thermally activated slip processes are greatly reduced by the presence of particles. This is consistent with the proposed mechanism given above. The effect of particles on recovery is not clear. Although the temperature at which the first evidence of recovery of strain hardening is observed is increased by the presence of a second phase, the later stages are affected in a somewhat confusing fashion. More experimentation is required to clarify this problem. (auth)

6376 (CF-60-12-21) HARDNESS OF VARIOUS VALVE SEAT AND BEARING MATERIALS FOR POSSIBLE USE IN THORIA SLURRY SYSTEMS. J. C. Moyers and H. A. Rundell (Oak Ridge National Lab., Tenn.). Dec. 9, 1960. 2p. OTS.

The hardness of several materials which were considered for use as valve seats and bearings in thorium oxide slurry systems was measured and reported for comparison. (auth)

6377 (HW-66909) TORSION TESTING OF PLUTONIUM. H. R. Gardner (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 21, 1960. 7p. OTS.

Results of torsion tests to determine the shear properties of plutonium are presented. Data on torsion properties are tabulated. (J.R.D.)

6378 (LMSD-288003) ELECTRONIC STRUCTURE OF BERYLLIUM. George C. Kuczynski (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Aug. 1959. 29p.

An attempt is made to correlate the structural insensitive physical properties of beryllium based on the theory of solids. An explanation of the decrease of lattice parameters ratio with temperature is offered, based on the Herring-Hill calculations of the wave functions for beryllium. The only real anomaly not properly explainable by the Herring-Hill model was found to be a very low value of Poisson's ratio. (C.J.G.)

6379 (NAA-SR-5439) THE VAPORIZATION BEHAVIOR AND THERMODYNAMIC STABILITY OF ZIRCONIUM CARBIDE AT HIGH TEMPERATURE. B. D. Pollock (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 1, 1961. 19p. Contract AT-11-1-GEN-8. OTS.

The vaporization behavior of zirconium carbide was studied in the temperature range 2620 to 2747°K by means of the Knudsen and Langmuir techniques in order to investigate the nature of the vaporization process and to determine the high temperature stability of the compound. At 2675°K, the standard free energy of formation was found to be −38.9 (±1.5) kcal. Agreement of the results of the two methods leads to the conclusions that accommodation coefficients must have been near unity and that molecular carbide species were not of major importance. Free energy functions were also estimated and used to derive a heat of formation, $\Delta H^\circ_{298} = -47.7 \pm 5.0$ kcal. (auth)

6380 (NASA-TN-D-283) OXIDATION BEHAVIOR OF BINARY NIOBIUM ALLOYS. Charles A. Barrett and James L. Corey (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Nov. 1960. 28p. OTS.

A screening study on the oxidation resistance of 33 binary alloy systems of niobium is reported. Alloys containing up to 25 nominal at. % of the alloying element were prepared by powder-metallurgy techniques and oxidized in air for 4 hr at 1000°C and 2 hr at 1200°C. The alloy systems showing the best oxidation resistance were Nb–Cr, Nb–Ti, Nb–Al, Nb–V, and, to a lesser extent, Nb–Fe, Nb–Co, Nb–Cu, and Nb–Ir. The chief factor contributing to this protection appears to be the ion size of the alloy addition. It should be slightly smaller than that of the Nb^{5+} ion in order to dissolve in the Nb_2O_5 oxide and lower the compressive stresses that crack the scale. (auth)

6381 (NASA-TN-D-374) EFFECTS OF VARIOUS AGING HEAT TREATMENTS AND SOLUTION-ANNEALING AND AGING HEAT TREATMENTS ON TENSILE, CREEP, AND STRESS-RUPTURE STRENGTHS OF INCONEL X SHEET TO TEMPERATURES OF 1,400°F. F. W. Schmidt, John Farquhar, and Ivo M. Kurg (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). June 1960. 33p.

The effects of six different heat treatments are presented on the tensile strength, on the minimum creep rate, on the 0.2% creep strength in 5 and 10 hr, and on the 10- and 100-hr stress-rupture strength of Inconel X sheet at 1,000, 1,200, and 1,400°F. The aging treatments gave the greatest tensile strength for all test temperatures. Aging treatments, in general, were superior for the 0.2% creep strength in 5 and 10 hr and the 10-hr stress-rupture strength at 1,000, 1,200, and 1,400°F. The solution-annealing and aging treatments had the best 100-hr stress-rupture strength at 1,200°F, whereas a short aging treatment was superior at 1,400°F. (auth)

6382 (NP-9605) INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. Progress Report No. 5 [for] April 16, 1960 to July 15, 1960. Technical Report No. 183. Jonathan Booker, Robert M. Paine, and A. James Stonehouse (Brush Beryllium Co., Cleveland). July 15, 1960. 31p. Contract AF33(616)-6540.

Progress on the properties of intermetallic beryllides and silicides under investigation is reported. Evaluation of the oxidation resistance of Hf_2Be_{21} and WSi_2 is discussed. Introductory work on the quantitative determination of the rate of oxidation of $ZrBe_{13}$ is reported. The oxidation products of this compound are identified as $ZrBe_{17}$ and BeO and the over-all rate of oxidation follows the cubic rate law. Thermal expansion data for WSi_2 and enthalpy data for Ta_2Be_{17} are given. With these data the experimental measurement of thermal expansion and enthalpy are completed for all the compounds under investigation. Additional transverse-rupture data are reported for WSi_2 and Hf_2Be_{17}. (auth)

6383 (NP-9662) AN INVESTIGATION OF THE PRECISION MECHANICAL PROPERTIES OF SEVERAL TYPES OF BERYLLIUM. Thomas J. Hughel (General Motors Corp. AC Spark Plug Div., Flint, Mich.). Apr. 4, 1960. 28p. Project No. 23-1010-601. (MR-120).

The mechanical properties of beryllium that are important in gyro applications are discussed. Methods for the measurement of the precision elastic limit and dimensional stability of beryllium are described. Results of the measurements of these properties on six modified forms of beryllium are given. It is shown that fine grain size and high BeO content favor high precision elastic limit and good dimensional stability. It is also shown that the addition of 1% iron as an alloying element improves the precision mechanical properties of beryllium without significantly altering the diamagnetic character. Prestraining is also shown to give large improvement in the precision mechanical properties. The variability of the precision elastic limit of standard production beryllium

is shown to be rather large, both within a single pressing and from lot to lot. (auth)

6384 (NP-9663) PARAMETRIC STUDIES OF METAL FIBER REINFORCED CERAMIC COMPOSITE MATERIALS. Bimonthly Report No. 5 [for] September 8, 1960 through November 7, 1960. Elbridge Z. Stowell and Tien-shih Liu (Southwest Research Inst., San Antonio). Nov. 8, 1960. 19p. Contract NOas 60-6077-c.

The stress distribution at elevated temperatures of a MFRC beam under a constant bending moment is calculated on the basis of a viscoelastic material. It is shown that there will be substantial changes in the stress distribution with time. Summary tables are presented for mixed oxides and for pure metals with melting points above 1649°C (3000°F). (auth)

6385 (NP-9664) FINAL REPORT [ON CERAMICS]. John T. Norton (Massachusetts Inst. of Tech., Cambridge). Nov. 1960. 9p. Contract Nonr 1841(24). OTS.

The solubility relationships of the monocarbides of V, Ti, Nb, Ta, and Zr were studied. The mutual solubility of Be_2C and ZrC was investigated. The solubility of pairs of carbides to systems containing three carbides was studied. The systems investigated were: TiC–VC–ZrC, TaC–VC–ZrC, and NbC–VC–ZrC. A detailed study was made of the system Ti–Ta–C and in particular the isothermal section of this system at 1800°C. A study was made of the isothermal sections at 1700°C of the systems Mo–W–C and Mo–Ti–C. Investigations were made of the problem of sintering refractory carbides in the presence of liquid-metal binders. (W.L.H.)

6386 (NP-9667) THE FRACTURE BEHAVIOUR OF SILVER CHLORIDE–ALUMINA COMPOSITES. Technical Report No. 11. T. L. Johnston, R. J. Stokes, and C. H. Li (Honeywell Research Center, Hopkins, Minn.). Dec. 1960. 43p. Includes Appendix: PREPARATION OF FRACTURE SURFACE REPLICAS. K. H. Olsen. Contract Nonr-2456(00). (HR-60-564).

The effect of alumina particles on the nucleation and growth of cracks through a silver chloride matrix was investigated. It was found possible to promote fibrous cracking in dispersion-strengthened silver chloride under notch-impact conditions at temperatures at which silver chloride alone cleaves brittlely. The modification of fracture behavior is thought to be due to the relaxation of hydrostatic stress beneath a notch by the nucleation of cavities near alumina particles. (auth)

6387 (NP-9682) A NOTE ON THE STRUCTURE OF TUNGSTEN CARBIDE. (Przyczynek do Zagadnienia Struktury Weglika Wolframu). Report No. 142/I-B. J. Leciejewicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1960. 5p.

The carbon atom positions in the unit cell and space group of tungsten carbide were determined using powder neutron diffraction method. (auth)

6388 (SCDC-2157) STRESS-STRAIN CHARACTERISTICS OF MATERIALS AT HIGH STRAIN RATES. PART IV. EXPERIMENTAL AND THEORETICAL ANALYSIS OF PLASTIC IMPACTS ON SHORT CYLINDERS. Charles H. Karnes (Texas. Univ., Austin. Structural Mechanics Research Lab.). June 21, 1960. 140p. For Sandia Corp. Contract AT(29-2)-621. OTS.

The effects of strain rate on the stress-strain characteristics of copper and lead were studied by measuring both stress and strain as functions of time using short cylindrical specimens supported at one end on a modified Hopkinson pressure bar and impacted at the other end by a steel projectile. Corresponding stresses and strains were computed according to an elementary nonstrain-rate theory (sometimes referred to as the von Karman theory) in which the dynamic stress-strain curve is assumed to be the same as the static stress-strain curve. Stresses and strains were also computed according to an elementary strain-rate theory (sometimes referred to as the Malvern theory) in which the dynamic stress may exceed the static stress for a given strain by an amount which depends upon the strain rate. It was found that the predictions of the nonstrain-rate theory agreed with measured values only for low impact velocities and for points at least two diameters from the impact end of the specimen. By proper choice of the flow or relaxation constant in the elementary strain-rate theory, measured and computed values of strain, or of stress, but not both simultaneously, could be brought into agreement. In the more general exponential-type, strain-rate law, two independent parameters appear. Presumably with two constants to adjust, this theory could be made to correctly predict both stresses and strains for the conditions under which the tests were performed. If this procedure forces the theory to account for variations which are actually caused by lateral inertia and shear, erroneous conclusions regarding the properties of the material will be drawn. Further study of the effects of shear and lateral inertia is indicated. (auth)

6389 (TID-6500) CREEP BUCKLING OF HEMISPHERICAL COPPER SHELLS. Annual Report. K. N. Tong (Syracuse Univ., N. Y. Research Inst.). June 1959. 26p. For Oak Ridge National Lab. Contract W-7405-eng-26. Subcontract No. 913. (ME-659-596A). OTS.

Creep deformation produced by a uniform external pressure on a thin hemispherical shell or spherical shell can lead to the collapsing of the shell at a finite time after the application of the load. The time required for the failure to materialize is called the critical time. The problem is to establish the critical time as a function of the pressure temperature, test, and specimen geometry, and properties of the shell materials. (W.L.H.)

6390 (TID-11300) THERMAL AND ELECTRONIC PROPERTIES OF THE RARE EARTH OXIDES. Edgar F. Westrum, Jr. (Michigan. Univ., Ann Arbor). Oct. 1960. 24p. OTS.

Presented at the Seminar on Rare Earth Research Developments, University of California, Conference Center, Lake Arrowhead, California.

Results of an investigation to determine the magnetic contribution to the thermodynamics of rare earth oxides and to gain information concerning the variation of the lattice heat capacity within isostructural series are presented. (J.R.D.)

6391 (TID-11303) THE EFFECT OF PRESSURE ON THE MOBILITY OF INTERSTITIAL OXYGEN AND NITROGEN IN VANADIUM. G. W. Tichelaar, R. V. Coleman, and D. Lazarus (Illinois. Univ., Urbana). July 1960. 22p. OTS.

Measurements of stress relaxation as a function of hydrostatic pressure up to 9000 kg/cm^2 were made on a vanadium sample containing approximately 0.1 at. % dissolved oxygen and 0.2 at. % dissolved nitrogen. At 83.0 to 98.0°C, the relaxation time due to dissolved oxygen is found to increase exponentially with pressure, the value at 9000 kg/cm^2 being about 1.7 times the value at 1 kg/cm^2. The pressure dependence of the stress relaxation can be interpreted in terms of an activation volume of 1.7 cm^3/mole

which is about equal to the molar volume of the diffusing oxygen atoms. The relaxation times due to the dissolved nitrogen were measured at 156.8 and 163.0°C. The values at 9000 kg/cm^2 are about 1.3 times the values at 1 kg/cm^2, the activation volume being about 1.1 cm^3/mole. (auth)

6392 (WADC-TR-58-476(Vol. I)(Rev.)) THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS. VOLUME I. ELEMENTS. (MELTING TEMPERATURE ABOVE 1000°F). Alexander Goldsmith, Thomas E. Waterman, and Harry J. Hirschhorn (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 30, 1960. 1½ in. thick. Project No. 7381. Contract AF33(616)-5212. OTS.

Thermophysical property data and their variation with temperature are presented for the elements melting above 1000°F, based on literature published during the period 1940 to 1957. Each reported value is shown and annotated, and recommended "most probable value" curves are given. Properties covered include the following: melting point, density, latent heats, specific heat, thermal conductivity, thermal diffusivity, emissivity, reflectivity, thermal expansion, vapor pressure, and electric resistivity. (auth)

6393 (WADD-TR-60-184) EFFECT OF BASIC PHYSICAL PARAMETERS ON ENGINEERING PROPERTIES OF INTERMETALLIC COMPOUNDS. Period covered: December 1958 to December 1959. D. L. Wood and J. H. Westbrook (General Electric Co. Research Lab., Schenectady, N. Y.). Mar. 31, 1960. 33p. Project No. 7350. Contract AF33(616)-6144.

A method for producing sound, uniform, and reproducible test specimens was devised and an investigation made of the effects of basic physical parameters on the mechanical properties. Tensile test specimens of Bi_2Tl and AgMg, produced directly by extrusion, have provided information applicable to future studies of the properties of NiAl. A pronounced yield point is found in AgMg. High strain rate sensitivity of the yield stress was observed, and the effects of grain size, composition, and test temperature were documented. Specimens will withstand loading only at very slow strain rates; after yielding occurs, however, rapid strain rates may be employed. With total elongations of more than 50%, the material is ductile under previously brittle conditions. (auth)

6394 (WADD-TR-60-542) STUDY OF RATE CONTROLLING PROCESS FOR COMPRESSIVE DEFORMATION OF HIGH PURITY ALUMINUM. Period [covered]: July 1958 to July 1960. A. E. Riesen (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). July 22, 1960. 26p. Project No. 7351. OTS.

A unique testing technique for determining the rate-controlling process for compressive deformation of high-purity aluminum at 297 to 358°K is discussed, and an attempt is made to correlate the activation energy for compression with some recognized rate-controlling process for tensile deformation of aluminum. It is shown that the compressive activation energy obtained, 5400 cal/mol, cannot be related to any known tensile deformation process. The results indicate a need for further experimental investigations to define the compression activation energy spectrum for aluminum over a broad temperature range. (auth)

6395 (AEC-tr-4272) DIFFUSION OF IRON IN SOME METALS. V. P. Vasil'evm, I. F. Kamardin, V. I. Skatskiĭ, S. G. Chernomoychenko, and G. N. Shuppe. Translated by Helen J. Chick (Los Alamos Scientific Lab.) from Trudy Sredneaziat. Gosudarst. Univ. im. V. I. Lenina, Fiz.-Mat. Nauki (N.S.) No. 12, 47-53(1955). 13p. JCL or LC.

The processes of diffusion of iron in tungsten, tantalum, nickel, and silver were studied by use of tracers. The primary emphasis was placed on determination of the diffusion coefficient dependence on temperature. (J.R.D.)

6396 (AEC-tr-4360) ELECTRICAL CONTACTS OF NOBLE METALS. A. Keil. Translated by L. L. Smith (Savannah River Lab.) from Metall 8, 611-14(1954). 10p. JCL.

A short survey is presented of various closing phenomena of electrical contacts. Noble metals are assigned in tabular form to definite contact groups, and some viewpoints for their selection are discussed. (W.L.H.)

6397 (CEA-tr-R-531) RÉSISTANCE ÉLECTRIQUE DE L'ALLIAGE Fe_3Al PENDANT LA DÉFORMATION À FROID ET LE TRAITEMENT THERMIQUE SUCCESSIF. (Electric Resistivity of Fe_3Al Alloy During Cold Deformation and Successive Thermal Treatment). Ya. (Ia.) P. Selisskiĭ. Translated into French by B. De Trezvinsky from Fiz. Metal. i Metalloved. 9, 633-5(1960). 8p.

The electric conductivity was measured in Fe_3Al alloy as a function of cold deformation and successive heat treatment. The variation in conductivity was produced simultaneously with a variation in texture both during the cold deformation and the reheat. However, the conductivity variation observed is not a direct consequence of the anisotropy of the alloy, but eventually appears following an oriented redistribution of compounds in the lattice of the solid solution. It must retain the stability of this eventual complex texture remaining in the alloy in spite of the relatively high reheat temperature. (T.R.H.)

6398 (CEA-tr-A-712) DIFFUSION ET CIRCULATION DE L'HYDROGÈNE DANS LE FER PUR ET DANS L'ACIER DANS LE DOMAINE DES HAUTES TEMPÉRATURES. (Diffusion and Circulation of Hydrogen in Pure Iron and Steel in Regions of High Temperatures). H. Schenck and H. Taxhet. Translated into French from Arch. Eisenhüttenw. 30, 661-79(1959). 43p.

A study was made of the diffusion and circulation of hydrogen in iron and steel as a function of temperature, pressure, and sample thickness. Experiments with samples of varying surface conditions revealed that the strong influence of activation reactions of the total process is equal to the sum of the activation energies of the partial processes. The permeability to hydrogen is inversely proportional to wall thickness. The effects of nonmetallic inclusions are minimal. (T.R.H.)

6399 (CEA-tr-R-727) DURETÉ DES ALLIAGES À BASE DE NICKEL À SOLUBILITÉ LIMITÉE, DÉTERMINÉE À LA TEMPÉRATURE AMBIANTE. (Hardness of Nickel-base Alloys of Limited Solubility, Determined at Room Temperature). P. I. Mel'nichuk (Mel'nichouk) and I. N. Frantsevich. Translated into French by B. De Trezvinsky from Izvest. Akad. Nauk Armyan., S.S.R., Ser. Tekh. Nauk No. 10, 124-5(1958). 7p.

To compare the resistance of interatomic bonds in alloys with their hardness at room temperature, the modulus of elasticity and calculated average values of atomic displacements from the nodes of the crystalline lattice in alloys were studied. The alloys used in the study were Ni–W, Ni–Cr, Ni–Ti, and Ni–Al at various concentrations. The results show that with equal amounts in at. % of additive element the hardness has a greater value for

alloys having greater crystalline lattice parameters. Disturbance of the ordering in the lattice of the solvent by foreign atoms represents a center of propagation for plastic deformation and, as a consequence, a center which increases hardness. (T.R.H.)

6400 (CEA-tr-R-990) NOUVELLE MÉTHODE D'ÉTUDE DE L'INFLUENCE DE L'HYDROGÈNE SUR LES PROPRIÉTÉS MÉCANIQUES DE L'ACIER AUX TÉMPERATURES ET PRESSIONS ÉLEVÉES. (A New Method for Studying the Effects of Hydrogen on the Mechanical Properties of Steel at High Pressures and Temperatures). M. B. Asvian. Translated by B. De Trezvinsky from Zavodskaya Lab. 25, 1000-3(1959). 9p.

The disadvantages and errors caused by using tubular and cylindrical steel samples for studying hydrogen effects at high pressures and temperatures are pointed out. A study was made using ring and half-ring samples cut from a tubular piece subjected to stress in the longitudinal planes and under internal pressure. The results demonstrate that this technique can be used to study the resistance of steels to hydrogen since the half-ring samples are very sensitive to embrittlement. (T.R.H.)

6401 (JPRS-5701) THE ISENTROPIC COMPRESSIBILITY OF ALUMINUM, COPPER, LEAD AND IRON AT HIGH PRESSURES. (Izentropicheskaya Szhimaemost' Alyuminiya, Medi, Svintsa i Zheleza pri Visokikh Davleniyakh). L. V. Al'tshuler, S. B. Kormer, M. I. Brazhnik, L. A. Vladimirov, M. P. Speranskaya, and A. I. Funtikov. Translated from Zhur. Eksptl'. i Teoret. Fiz. 38, 1061-73 (1960). 24p. (OTS-60-41488). OTS.

A method for measurement of the propagation velocity of weak perturbances behind the front of powerful shock waves is described. Two sound velocities corresponding to elastic and plastic states of matter were detected. With the aid of the methods developed, the velocity of sound and the isentropic compression moduli for aluminum, copper, iron, and lead were determined in the pressure range of 0.4 to 3.5×10^6 atm. The values of thermal energies, temperature of shock compression, and Gruneisen coefficients are estimated. (auth)

6402 (NP-tr-507) DECOMPOSITION OF SOLID SOLUTIONS IN THE NICKEL–GOLD SYSTEM. PART I. (Raspad Tverdykh Rastvorov v Sisteme Nikel (-Zoloto. 1.). V. V. Sanadze and G. V. Gulyaev (Gulyayeyv). Translated from Kristallografiya 4, 526-33(1959). 15p. OTS.

Phase studies were conducted on Au–Ni alloys at 20 to 925°C using the sequential hardening method of analysis. (C.J.G.)

6403 (NP-tr-509) NOTE ON QUESTION OF K-STATE IN NICKEL–CHROMIUM ALLOYS. (K Voprosu ϕ K-Sostoyanfi v Splavakh Nikel'–Khrom). A. V. Prograshchenko and G. E. (Ye.) Chetverkina. Translated from Izvest. Vysshikh Ucheb. Zavedenfi, Chernaya Met. No. 3, 106-9(1960). 11p. OTS.

Studies were made on the development of the K-state in Cr–Ni alloys. From data on the electric resistance of the alloy it was determined that the hardening of samples from 1000°C is not effective enough to avoid completely the development of the K-state. (C.J.G.)

6404 MEASUREMENT OF HARDNESS AT VERY HIGH TEMPERATURES. L. M. Fitzgerald (Cavendish Lab., Cambridge, Eng.). Brit. J. Appl. Phys. 11, 551-4 (1960) Dec.

A new method of determining hardness at high temperatures was developed and is being used, particularly, to study materials having melting points in the region of 3000°C. The principle of the hardness measurement is the determination of the height of rebound of a spherical indenter. Tungsten carbide balls of $\frac{1}{8}$ in. diameter are dropped on to the specimen from a height of about 22 in. The method of measurement makes use of a photomultiplier tube and an electronic timing device. A graphite-tube resistance-heated furnace is used to obtain the temperatures required. The furnace chamber and measuring apparatus is maintained at a vacuum of 0.1 μ (10^{-4} mm Hg) and is surrounded by a water-cooling jacket. The plastic deformation of hard carbides as the temperature is increased was measured with this apparatus. Some typical results are given. (auth)

6405 EFFECT OF SODIUM EXPOSURE ON THE MECHANICAL PROPERTIES OF ZIRCONIUM. J. C. Bokros (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Corrosion 17, 31t-4t(1961) Jan.

It was found that surface oxides which developed on zirconium in impure sodium significantly lowered the fatigue life at elevated temperatures. Hydrogen absorption had little effect on the fatigue life at elevated temperatures but lowered the fatigue life at room temperature. Critical recrystallization which occurred above 950°F in zirconium (a phenomenon unrelated to the presence of sodium) reduced the fatigue life at elevated as well as low temperatures. The effects attributable to sodium (i.e., the formation of surface oxide and absorption of reasonable amounts of hydrogen), did not significantly alter the tensile properties of zirconium at high temperatures. (auth)

6406 MARTENSITE TRANSFORMATIONS IN THE TITANIUM–ZIRCONIUM SYSTEM. V. N. Gridnev, V. I. Trefilov, and V. N. Minakov (Inst. of Physics of Metals, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 134, 1334-6(1960) Oct. 21. (In Russian)

Complex methods were used in the investigation of martensite transformation temperature dependence on the content of Ti–Zr alloy. (R.V.J.)

6407 THE USE OF THE EMF METHOD IN STUDYING THE THERMODYNAMICS OF LOWER TUNGSTEN OXIDES AT HIGH TEMPERATURES. Ya. I. Gerasimov, I. A. Vasil'eva, T. P. Chusova, V. A. Geĭderikh, and M. A. Timofeeva (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 134, 1350-2(1960) Oct. 21. (In Russian)

The electromotive force of $WO_x/ZrO_2CaO/Fe_{0.95}O$ (Fe with x = 2.719, 2.66, 2.39, 1.90, 1.69, and 1.45) cells was measured at 900 to 1230°K. The heat capacity of O_2 and W were used as standard thermodynamic magnitudes, and the equation $c_p = 17.83 + 1.89 \times 10^{-3}T - 3.342 \times 10^5 T^{-2}$ (order of accuracy ±3%) was derived on the basis of c_{p298} for WO_2. Based on the values of S^0_{298} for W and O_2, S^0_{298} for WO_2 = 15.0 ± 1.5. (R.V.J.)

6408 THE INFLUENCE OF THE TIME OF AGEING ON THE FORMATION AND COMPOSITION OF THE γ'-PHASE IN Ni–Cr–W–Al–Ti ALLOYS. R. B. Golubtsova and L. A. Mashkovich (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 134, 1353-5(1960) Oct. 21. (In Russian)

The electrolytic isolation of saturated phases helped to establish the metalloid γ' phases and to determine the influence of long-time annealing on the composition and structure of the phase. (R.V.J.)

6409 ON TRANSFORMATIONS IN A CHROMIUM–NICKEL SYSTEM. V. N. Svechnikov and V. M. Pan (Inst. of Metallophysics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R. No. 7, 917-20(1960). (In Ukrainian)

A chromium-nickel system was investigated within limits of 50%-nickel using highly sensitive dilatometry, differential thermal, roentgenostructural, and microstructural analysis methods. It is shown that eutectoid transformation in this system is actually absent. The variation of the solubility of nickel in chromium with temperature was determined roentgenographically. The solubility falls sharply from 40.5%-Nickel to practically zero on lowering the temperature from 1340 to 850°C. (auth)

6410 INVESTIGATION OF THE ELECTRIZATION AND RHEOLOGICAL PROPERTIES OF NA-LUBRICANT. Yu. F. Deĭnega and A. V. Dumanskiĭ (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R. No. 7, 926-8(1960). (In Ukrainian)

An investigation was carried out on the kinetics of the change in the shearing stress and the electric potential of sodium lubricants under conditions of transition from elastic deformations through the ultimate strength to a steady flow. The nature of the change in potential and shearing stress is shown to depend essentially on the initial orientation of the structure. (auth)

6411 INTERNATIONAL CONFERENCE ON PLUTONIUM METALLURGY, GRENOBLE, APRIL 1960. E. Zimmer (Societa Ricerche Impianti Nucleari, Milan). Energia nucleare (Milan) 7, 685-90(1960) Oct. (In Italian)

The International Conference on Plutonium Metallurgy, organized by the "Société française de métallurgie" and the "Commissariat à l'énergie atomiques," was held at Grenoble in April 1960. Plutonium physical properties, alloys, ceramic materials, and nuclear fuels were dealt with in this occasion. An account is given of the papers delivered at the Conference. (auth)

6412 LEAD, ITS ALLOYS AND COMPOUNDS. Edward J. Mullarkey (Lead Industries Assn., New York). Ind. Eng. Chem. 53, 82-6(1961) Jan.

The applications of lead, its alloys and compounds as construction materials are reviewed. The effects of nickel on the properties of lead were investigated. It was found that an alloy containing 0.69 wt. % lithium has a much higher tensile strength than pure lead. It was confirmed that lead has appreciable solubility in iron. Experimental results indicated that dispersal of metal powder in lead improved its tensile properties. A PbO-based dry film lubricant for bearings was developed which provides high temperature, high load, and high speed performance. A bearing material of lead and Teflon in a sintered bronze matrix backed with tin-plated steel was also developed. The application of basic carbonate of white lead for maintaining temperatures tolerable for man and instruments in space is discussed. The use of lead as the heavy metal component in Peltier devices for refrigerator-freezer appliances was explored. A nylon-sheathed lead "fiber" was used to provide adequate sound blocking at efficiences better than those predicted on the basis of weight alone. The properties of lead anodes are discussed. Porcelain enameled magnesium showed excellent resistance to abrasion and chemical attack when standard lead oxide frits were used. (M.C.G.)

6413 STUDIES IN LITHIUM OXIDE SYSTEMS: IX. $Li_2O-Al_2O_3-TiO_2$. K. H. Kim and F. A. Hummel (Pennsylvania State Univ., University Park). J. Am. Ceram. Soc. 43, 611-14(1960) Dec.

Compatible phases in the system $Al_2O_3-Li_2O-TiO_2$ at various temperature levels were determined by solid-state reactions for the portion of the ternary system bounded by $Li_2O-Al_2O_3$, Li_2O-TiO_2, Al_2O_3, and TiO_2. The existence of a ternary compound, $Li_2O-Al_2O_3-4TiO_2$, and nine joins was established. The ternary compound has a lower limit of stability at 1090 ± 15°C and dissociates and recombines rapidly at 1380 ± 15°C. (auth)

6414 INITIAL SINTERING KINETICS OF BERYLLIUM OXIDE. E. A. Aitken (General Electric Co., Schenectady, N. Y.). J. Am. Ceram. Soc. 43, 627-33(1960) Dec.

The initial sintering kinetics of beryllium oxide are examined, including the effects of calcining temperature, purity, and water-vapor content of the sintering atmosphere. Sintering occurs by a diffusion mechanism in dry-air atmospheres. Small additions of MgO to BeO increase the sintering rate markedly. The diffusion constant calculated from sintering data for pure BeO is three orders of magnitude lower than the measured diffusion of beryllium in BeO. Water vapor in the sintering atmosphere slows the shrinkage rate of pure BeO. (auth)

6415 ACTIVATION ENERGY FOR DIFFUSION OF ^{133}Xe THROUGH MgO–Ni CERMET COMPACTS. W. E. Moody, W. D. Whitehead, and W. W. Kriegel (North Carolina State Coll., Raleigh). J. Am. Ceram. Soc. 43, 634-40 (1960) Dec.

The Xe^{133} was produced by irradiation of UO_2, which formed the central or core portion of small disks made from a 66% nickel and 34% MgO cermet material. Diffusion rates through this material were determined at 800 to 1100°C. The activation energy for diffusion was determined to be 4.4 ev with the diffusion coefficient given by the equation $D = 1.85 \times 10^7 \, e^{-(4.4 \text{ ev/kT})} \, cm^2/sec$. The mechanism of diffusion appeared to be of the atom-vacancy interchange type. (auth)

6416 FLEXURAL STRENGTH OF SPECIMENS PREPARED FROM SEVERAL URANIUM DIOXIDE POWDERS; ITS DEPENDENCE ON POROSITY AND GRAIN SIZE AND THE INFLUENCE OF ADDITIONS OF TITANIA. F. P. Knudsen, H. S. Parker, and M. D. Burdick (National Bureau of Standards, Washington, D. C.). J. Am. Ceram. Soc. 43, 641-7(1960) Dec.

Flexural strengths of specimens prepared from four uranium dioxide powders were determined at room temperature and at 1000°C. The relation of the strength (S) to porosity (P) and to grain size (G) could be represented by the expression $S = kG^{-a} \, e^{-bP}$, where k, a, and b are empirical constants that differed with test temperature but did not differ for the different urania powders used. Additions of titania were very effective in promoting sintering and additions of 0.50 or 0.75 wt. % markedly increased the strength of the specimens. (auth)

6417 OBSERVATION BY TRANSMISSION ELECTRON MICROSCOPY OF STACKING FAULTS IN A BODY-CENTERED CUBIC METAL: NIOBIUM. A. Fourdeux and A. Berghezan (European Research Assn., S. A., Brussels). J. Inst. Metals 89, 31-2(1960) Sept.

Transmission electron microscopy studies were made of niobium sponge melted several times in vacuo and in argon. Foils made from the resulting ingot revealed, in addition to

the individual dislocations, networks, and interesting interactions between dislocations, a large number of stacking faults with their associated partial dislocations. Micrographs show some aspects of the stacking-fault ribbons within which the characteristic interference fringes can be seen. These ribbon dislocations cover an extensive area; so it is possible to observe in certain cases the interactions of the individual particles. These are similar to those observed by Whelan on stainless steel and Matthews on evaporated foils of silver, gold, and copper. (B.O.G.)

6418 PHASE TRANSFORMATIONS IN THE Cr17Ni7Al TYPE STEELS. E. G. Fel'dgandler and M. V. Pridantsev (Central Scientific Research Inst. of Ferrous Metals, [USSR]). Metalloved. i Termichesk, Obrabotka Metal. No. 11, 2-7(1960) Nov. (In Russian)

Although the heat treatment of austenite-martensitic stainless steels was widely studied, the phase transformations occurring during the process are not well known. The kinetics of the strengthening and of the martensitic transformation of a steel containing 0.075% C; 0.6% Mn; 0.31% Si; 16.4 to 16.9% Cr; 7.2 to 7.4% Ni; 0.6 to 1.2% Al; and 0.02 to 0.04% N_2 was studied as a function of the temperature and the duration of annealing. It was established that the maximum strengthening and the martensite formation are independent of each other. Soaking the metal at a temperature of 450 to 500° for 3 hr does not improve the strength of the metal although it corresponds to the maximum of the martensite formation. Increased strength is connected with the deposition of an intermetallic compound $(FeNi)_3Al$; to a lesser extent, with the martensitic transformation; and with the precipitation of microdispersed carbides. (TTT)

6419 ON OXIDE FILMS AND SCALES OF Fe–Si–Cr SYSTEM ALLOYS AT HIGH TEMPERATURES. Masataka Sugiyama and Tadayuki Nakayama. Nippon Kinzoku Gakkaishi 24, No. 6, 370-4(1960). (In Japanese and English)

Oxide films and scales produced on the surface layers of iron–silicon–chromium system alloys (ca. 1 to 7% silicon, 5 to 19% chromium) were observed when they came into contact with air at high temperatures (700 to 1200°C) using transmission electron diffraction, x-ray diffraction, and a metallurgical microscope. It was verified that ca. 3 to 7% silicon–chromium–iron system alloys are covered mainly with Cr_2O_3 or α-$(Cr,Fe)_2O_3$ crystal films in the earliest stage of oxidation at 700 and 1000°C. Amorphous SiO_2 films were previously detected on the surfaces of ca. 1 to 6% silicon–iron system alloys at 700 to 1000°C oxidation, but this kind of oxide films was not observed on the surfaces of ca. 1 to 4% silicon–chromium–iron system alloys heated in air under the same conditions. The present studies also clarified experimentally that the heat-resisting films of iron–silicon–chromium system alloys oxidized in air at 1100 and 1200°C for 7 hr are composed of fine Cr_2O_3 crystals. (auth)

6420 CARBIDES IN MOLYBDENUM STEELS. Tomo-o Sato, Taiji Nishizawa, and Koreaki Tamaki. Nippon Kinzoku Gakkaishi 24, No. 6, 395-400(1960). (In Japanese and English)

Carbides isolated electrolytically from molybdenum steels were studied by x-ray, chemical, and thermomagnetic analyses and by electron-microscopic observations in order to investigate the nature of carbides in the steels and to determine the carbide-phase diagram of molybdenum steel below the eutectoid temperature. In the case of thermal treatment at 700°C for 24 hr, the carbides formed by tempering are quite different from those formed by isothermal transformation. But, after a prolonged treatment at 700°C, carbides in both the structures tend to approximate each other gradually, and five kinds of carbides, M_3C, $M_{23}C_6$, ξ, M_2C, and M_6C, appear, as the atomic ratio Mo : C in the steel increases. Among these carbides, M_3C and $M_{23}C_6$ are ferromagnetic, of which the Curie points are 215 to 181°C and 312 to 183°C, respectively. The composition ranges of carbides in molybdenum steels at 700°C are as follows. M_3C : 6.67% C, 0 to 2.5% Mo; $M_{23}C_6$: 5.0 to 6.0% C, 5.5 to 13.5% Mo; ξ : 5.5 to 6.0% C, 30 to 37% Mo; M_2C: about 6% C, 70% Mo; and M_6C : 2.5 to 2.8% C, 45 to 62% Mo. (auth)

6421 THE INFLUENCE OF THE CARBON CONCENTRATION ON THE TWISTING CREEP OF HARDENED STEELS. Hiroshi-Muro. Nippon Kinzoku Gakkaishi 24, 490-3(1960). (In Japanese)

The microplasticity of hardened ball-bearing steel under sustained twisting moment (shear stress of 7.8 ~ 15.0 kg/mm^2) between room temperature and 300°C, was previously reported. It was suggested that the total strain increment between designated temperatures (named cumulative flow) of quenched specimens depends upon the carbon concentration of quenched martensite. The cumulative flow for quenched carbon steels of various carbon contents was investigated and its dependency on the carbon concentration of martensite was established. For tempered specimens the cumulative flow below tempering temperature was also influenced by the primary carbon concentration. By means of twisting-creep tests, cold-drawn ball-bearing steel also exhibited a tendency fairly resembling that of quenched low-carbon steel. (auth)

6422 THE PROPERTIES OF NITRIDED TITANIUM. Koichi Nakano, Shunji Yamamoto, Hiroshi Kobayashi, and Akira Takamura. Nippon Kinzoku Gakkaishi 24, 500-4 (1960). (In Japanese)

Laboratory tests were carried out on the wear resistance, corrosion resistance, and mechanical properties of titanium nitrided in a nitrogen stream at 850°C for 16 to 80 hr. The wear resistance of titanium was remarkably improved by nitriding. According to the results of sliding experiments, nitrided titanium showed satisfactory surface properties alone and in combinations with the following materials: cast iron and hard chromium plating in unlubricated conditions; and bronze, cast iron, carbon steel, low alloy steel, Carbaite, bakelite, and hard chromium plating in lubricated conditions. On the whole, the corrosion resistance of titanium was not affected adversely by nitriding and, further, it was interesting to note that the nitriding even improved the resistance in reducing environments. The effect of nitriding on the mechanical properties of titanium was negligible. (auth)

6423 ON STRAIN AGE HARDENING OF CARBON STEEL (STUDY ON ANNEAL HARDENING OF TWO PHASE ALLOYS, 1st REPORT). Kazuyoshi Nishino and Kiyoharu Takahashi. Nippon Kinzoku Gakkaishi 24, 514-18(1960). (In Japanese)

Strain age-hardening of carbon steel occurs in two stages during annealing after cold-working. The primary hardening at about 100°C takes place within the ferrite phase, and it may be reasonably explained by Cottrell's mechanism. The secondary, hardening in the range of 150 to 340°C, becomes marked with the increase of the carbon content. It is accompanied by a rise of yield point upon measuring under a stress of the same kind and direction as those of prior

workings. This shows that the latter hardening is associated with the phase boundaries, since the hardening is not so pronounced in the ferrite phase and that it is due, as in the case of α brass, to the removal of Bauschinger effect, which is more marked with the higher carbon steels. The secondary hardening in a given steel is, hence, chiefly affected by the arrangement, the shape, and size of the cementite particles. (auth)

6424 SOME PHENOMENA RELATED WITH STRAIN AGE-HARDENING OF CARBON STEEL (STUDY ON ANNEAL HARDENING OF TWO PHASE ALLOYS, 2nd REPORT). Kazuyoshi Nishino. Nippon Kinzoku Gakkaishi 24, 518-22(1960). (In Japanese)

A slight application of secondary working, differing in type from the primary, caused a considerable hardening of carbon steel, probably indicating that the strain age-hardening is brought about not only by low temperature annealing but by mechanical treatment, and that it is due to the destruction of a deformation structure that exhibits a marked anisotropy in an elastic effect. The destruction may be induced by internal stress, thermal diffusion, and cold working. The deformation structure is inferred to be such that the cementite particles and the vacancy aggregates therein present an anisotropic arrangement and shape depending on the working condition, and the dislocation loops created around them show a back stress. (auth)

6425 ELECTRON-MICROSCOPIC OBSERVATION ON CHEMICALLY ETCHED SURFACES OF POLYCRYSTALLINE ZIRCONIUM. Tetsuhiko Tomiki and Shiro Ogawa. Nippon Kinzoku Gakkaishi 24, 522-6(1960). (In Japanese)

The etching process of polycrystalline zirconium by acid was investigated by means of an electron microscope, using the replica method. Mainly, aqueous solution of hydrofluoric acid and, complementarily, "Gulbransen reagent" and concentrated sulfuric acid were used as etching reagents. Etch pits with density of $10^9/cm^2$ appeared at first on a zirconium surface attacked by aqueous solution of hydrofluoric acid. With increasing etching duration, they were transformed into semispherical small depressions, which were developed inwards and finally fused with each other. Thus, the etched surface was ultimately composed by coalescence of these developed depressions. It was concluded that the pits do not always correspond to dislocations. The etching process by "Gulbransen reagent" and by concentrated sulfuric acid was almost the same as that by aqueous solution of hydrofluoric acid. (auth)

6426 ON THE EQUILIBRIUM DIAGRAM OF Fe–Ni–Si SYSTEM AND THE TERNARY COMPOUND σ-PHASE APPEARING IN THIS SYSTEM (FUNDAMENTAL RESEARCH OF CONSTANT PERMEABILITY ALLOYS, 2nd REPORT). Shuzo Takeda, Yoshiroh Iwama, and Akira Sakakura. Nippon Kinzoku Gakkaishi 24, 534-8(1960). (In Japanese)

By means of microscopic observation as well as magnetic and dilatometric analyses, the constitution of ternary alloys of the iron-rich Fe-Ni-Si system was investigated and its equilibrium diagram for solid phase reaction was determined. The σ-phase was found to be ferromagnetic and formed by a peritectoid reaction $\alpha + \gamma \rightarrow \sigma$, having a maximum temperature at about 920°C, at an original composition of about 29% Ni, 11% Si, and 60% Fe, corresponding to the chemical formula $Fe_{11}Ni_8Si_4$, after solidifying through an eutectic reaction, Melt $\rightarrow \alpha + \gamma$. It was also found that the composition of a constant permeability alloy "Senperm" in this system, extends over a region where it shows a homogeneous α-phase at higher temperatures and then precipitates σ-phase with lowering temperature owing to its solubility change. (auth)

6427 ON THE CRYSTAL STRUCTURE OF A TERNARY COMPOUND σ-PHASE APPEARING IN "SENPERM" ALLOYS (FUNDAMENTAL RESEARCH OF CONSTANT PERMEABILITY ALLOYS, 3rd REPORT). Yoshiroh Iwama and Shuzo Takeda. Nippon Kinzoku Gakkaishi 24, 538-40 (1960). (In Japanese)

It was previously reported that in alloys of the Fe-Ni-Si system, a ferromagnetic ternary compound σ-phase was formed and its chemical formula was inferred to be $Fe_{11}Ni_8Si_4$ (60.2% Fe, 28.8% Ni, 11.0% Si). The crystal structure of this σ-phase was studied by an x-ray diffraction technique with powder camera and Geiger-counter spectrometer. Through interpretation of powder-pattern photographs and recording charts, as well as measurement of density of an alloy, almost consisting of σ-phase, by pycnometer method, the following results were obtained: the σ-phase has a crystal structure of the simple cubic type with a lattice parameter $a_0 = 6.148Å$; its measured density is 7.30 g/cc (at 17°C); it contains 20 atoms, or one molecule of $Fe_{11}Ni_8Si_4$ in its unit cell. (auth)

6428 EFFECT OF Si ON HIGH TEMPERATURE OXIDE FILMS IN HEAT-RESISTING ALLOYS. Masataka Sugiyama and Tadayuki Nakayama. Nippon Kinzoku Gakkaishi 24, 541-4(1960). (In Japanese)

By use of the transmission-electron diffraction method, the initial oxide films of A.I.S.I. Type 302 B (2.45% Si), 19-9 DL (0.50% Si), Durimet 20 (1.27% Si), and Nichrome (JIS No. 1, 0.5 ~ 1.5% Si) oxidized in air at 700 to 900°C were studied. A solution of bromine in methanol (1 : 50 by vol.) was satisfactorily used for isolating the oxide films from these alloys. The electron-diffraction patterns obtained from initial oxide films (700 to 900°C) of the alloys showed the existence of rhombohedral-type (mainly Cr_2O_3 or α-$(Cr,Fe)_2O_3$) and spinel-type oxides, and no such special oxides as SiO_2 could be observed in the patterns. However, α-cristobalite crystals were detected when the films were heated at 1200°C for 1 to 3 hr. This showed that the special heat-resisting films consisting of amorphous SiO_2 are formed on the surfaces of alloys in the earliest stage of oxidation. (auth)

6429 ZIRCALOY CLADDING PERFORMS WELL IN PWR. B. Lustman, M. L. Bleiberg, E. S. Byron, J. N. Chirigos, J. G. Goodwin, and G. J. Salvaggio (Westinghouse Electric Corp., Pittsburgh). Nucleonics 19, No. 1, 58-63 (1961) Jan.

A destructive examination was made of Zircaloy-2-clad natural-UO_2 blanket fuel elements from the Shippingport PWR. The examination, plus operation and fabrication experience, increased confidence in zirconium-base alloys as cladding for UO_2-fuel rods. It was concluded that Zircaloy-2 cladding performed satisfactorily after a peak burn-up of ~9000 Mwd/ton UO_2; radiation exposure in 475°F water at 5.5 to 6.0×10^{21} nvt (fast) results in a marked elevation of yield and tensile-strength characteristic of fast neutron exposure of structural metals; local hydriding of cladding aggravated failure of defected elements only in in-pile hot-water loop tests; and the elimination of nickel delays or prevents hydriding failures. The only other type of failure encountered during the tests was "waterlogging," which is characteristic of unbonded fuel elements and can occur with any cladding material. Fatigue and tensile properties are tabulated for irradiated and unirradiated specimens of

Zircaloy-2. Graphical representations are given of data on fast flux effects on 600°F tensile properties; notched impact tests; hydriding of defected fuel rods; and hydrogen absorption by Zircaloy-2 and -4 in 343°C water containing excess hydrogen. (B.O.G.)

6430 ISOTOPE EFFECT IN Nb_3Sn. G. E. Devlin and E. Corenzwit (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. 120, 1964-5(1960) Dec. 15.

The isotope effect on the superconducting transition of Nb_3Sn was measured. The value of −0.08 for the exponential factor is only one-fifth that of the elemental superconductors which were reported. (auth)

6431 NEUTRON DIFFRACTION STUDIES OF CHROMIUM-MODIFIED Mn_2Sb. W. H. Cloud (E. I. du Pont de Nemours and Co., Wilmington, Del.), H. S. Jarrett, A. E. Austin, and E. Adelson. Phys. Rev. 120, 1969-70 (1960) Dec. 15.

Existence of a ferrimagnetic to antiferromagnetic phase transition with decreasing temperature in Mn_2Sb modified with 2.3 wt. % chromium is confirmed by neutron diffraction. (auth)

6432 NUCLEAR SPIN AND MOMENTS OF 14-Hr Ga^{72}. W. J. Childs, L. S. Goodman, and L. J. Kieffer (Argonne National Lab., Ill.). Phys. Rev. 120, 2138-46 (1960) Dec. 15.

The hyperfine structure of the 14-hr isotope Ga^{72} was investigated by use of atomic-beam magnetic-resonance techniques. The nuclear spin was found to be 3, the magnetic dipole moment $\mu_I = -0.132196 \pm 0.000013$ nm (subject to correction for a possible hyperfine anomaly), and the electric quadrupole moment $Q = +0.718 \pm 0.007$ barn. (auth)

6433 SPIN CONFIGURATION AND MAGNETIZATION PROCESS IN DYSPROSIUM. U. Enz (Philips' Research Labs., Eindhoven, Netherlands). Physica 26, 698-9(1960) Sept. (In English)

It is shown that the properties of dysprosium can be unambiguously explained by assuming a helical spin configuration. A proposal is given for the spin structure from 85 to 178.5°K, which is developed to show the transition from the ferromagnetic state to a helical state with a finite angle α_0 for the direction of magnetization, consistent with the observed peak found in specific heat data. In a similar approach to the Herpin calculation for the behavior of a helix in a perpendicular magnetic field, it was found that a relative magnetization of ~5% is attained in the critical field, H_K. In fields surpassing H_K, saturation is not reached immediately, the relative magnetization being ~85% theoretically. Complete saturation takes place in a field of ~9/4 H_K. An estimate is given for the characteristic angle of the helical structure, $\alpha_0 = \sim 12°$, for $H_K = 10^3$ Oe. (B.O.G.)

6434 THERMAL MOTION IN PALLADIUM HYDRIDE STUDIED BY MEANS OF ELASTIC AND INELASTIC SCATTERING OF NEUTRONS. J. Bergsma (Institutt for Atomenergi, Kjeller, Norway) and J. A. Goedkoop. Physica 26, 744-50(1960) Sept. (In English)

A single-crystal neutron-diffraction investigation of electrolytically loaded palladium hydride of composition $PdH_{0.63}$ confirms the NaCl type arrangement found previously for material loaded from the gas phase. The root-mean-square displacements due to thermal motion of the palladium and hydrogen atoms at room temperature are found to be 0.10 ± 0.01 and 0.24 ± 0.02 A, respectively. Measurements of the total neutron scattering cross section as a function of neutron energy and of the energy distribution of 0.004-ev neutrons scattered at 90° are reported and interpreted in terms of an Einstein model for the proton vibrations with a fundamental frequency corresponding to 0.056 ± 0.002 ev. From this the root-mean-square displacement of the protons relative to the palladium sublattice at room temperature is estimated to be 0.22 ± 0.02 A, in agreement with the values found by diffraction. The cold neutron scattering data give information about the heat motion of the palladium atoms. Interpreted on a Debye model they yield a Debye temperature of 300 ± 25°K and a root-mean-square displacement of 0.10 ± 0.10 A. (auth)

6435 NON-DESTRUCTIVE METALLOGRAPHY OF LIGHT AND ULTRA-LIGHT MATERIALS (ALUMINUM, MAGNESIUM, BERYLLIUM AND THEIR ALLOYS). PART 3. Pierre A. Jacquet (Constructions et Armes Navales, [Paris]; Office National d'Etudes et de Recherches Aeronautiques, [Paris]; and Commissariat à l'Énergie Atomique, [Paris]). Rev. aluminium 37, 977-87(1960) Sept. (In French)

Detailed metallographic procedures are given for magnesium alloys, magnesium, and beryllium. The procedures involve an electrolytic buffer which offers advantages in simplicity, ease of operation, and improved results. (T.R.H.)

6436 THE CRYSTAL STRUCTURE OF BADDELEYITE (MONOCLINIC ZrO_2). N. V. Belov (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. 5, 436-8(1960) Nov.-Dec.

It was found that the structure of baddeleyite is merely a distortion of the high-temperature structure of ZrO_2. This high-temperature structure consists of a primitive cubic stacking of oxygen atoms, in which half of the cubes are populated. The unit cell contains two layers of oxygen ions between two layers of cations. In the structure of baddeleyite one of the oxygen layers is distorted very slightly, while the other layer is considerably displaced and then undergoes transformation to a tetragonal pattern. (M.C.G.)

6437 THE CRYSTAL STRUCTURE OF YAl_2. P. I. Kripyakevich (L'vov State Univ.). Soviet Phys.-Cryst. 5, 440-1(1960) Nov.-Dec.

In a study of the Y−Al system, x-ray analysis showed the presence of a compound with 57.3 wt. % yttrium. The x-ray intensities were calculated on the assumptions that the compound under study had the composition YAl_2 and the $MgCu_2$ structure type. The calculated intensities agreed well with experimental intensities. The following interatomic distances were determined in YAl_2: Y−Y = 3.38, Al − Al = 2.86, and Y − Al = 3.24 A. (M.C.G.)

6438 SOME DISTINGUISHING FEATURES OF CRYSTAL GROWTH IN FERRITES HAVING THE GARNET STRUCTURE. V. A. Timofeeva (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. 5, 453-6 (1960) Nov.-Dec.

The possibility of growing ferrite single crystals with the general formula $R_3Fe_5O_{12}$ by crystallization from solutions in molten lead oxide was investigated. Mixtures composing the tricomponent system $PbO-Fe_2O_3-R_2O_3$, where R_2O_3 is a rare earth oxide or Y_2O_3, were brought to a homogeneous condition by melting. The temperature was then gradually decreased. Ferrite crystals containing Y, Dy, Gd, Er, Ho, Yb, and Nd were grown by this method.

The properties and distortions in the crystals are discussed. (M.C.G.)

6439 PROPERTIES OF PLASMA-SPRAYED MATERIALS. M. A. Levinstein (General Electric Co., Cincinnati), A. Eisenlohr, and B. E. Kramer. Welding J. (N. Y.) 40, 8-s-13-s(1961) Jan.

New arc-plasma equipment for the spraying of metallic and nonmetallic materials is briefly described, including one gun for powders and another for wire. With the arc plasma as a heat source, the highest-melting-point materials can be sprayed. With this equipment, specimens were prepared for the determination of selected physical and mechanical properties of arc-plasma deposited materials. The materials investigated were tungsten, molybdenum, hafnium carbide, tantalum carbide, cerium oxide, and hafnium oxide. Tungsten and molybdenum were sprayed in both wire and powder form, while the oxides and carbides were in powder form. Spraying parameters were established based on density and microstructure. Selected physical properties measured were density, thermal expansion, and hardness. Crystallographic studies were made to determine stability of the materials under the ultra-high-temperature spraying conditions. The deposited materials were analyzed for oxygen and nitrogen. Tensile testing of the metals was conducted at various temperatures, including 4500°F for tungsten and 3000°F for molybdenum. (auth)

6440 BRITTLE FRACTURE CHARACTERISTICS OF A REACTOR PRESSURE-VESSEL STEEL. E. T. Wessel and W. H. Pryle (Westinghouse Research Labs., Pittsburgh). Welding J. (N. Y.) 40, 41-s-8-s(1961) Jan.

The brittle fracture characteristics of Type ASTM A302B steel were determined with material from a 7-in.-thick plate for both the as-received (normalized) condition and after a heat treatment consistent with the thermal cycles encountered during the fabrication of a reactor pressure vessel. The heat-treated steel was found to be slightly more notch sensitive and had a somewhat higher transition temperature than the as-received steel. In comparison with other steels that have been studied under similar conditions, the A302B steel was found to be considerably more brittle-fracture resistant. For the particular test conditions used, average applied stresses in excess of the normally measured yield strength were required to cause fracture in the A302B steel even in the presence of a pre-existing large crack at temperatures above −150°F. Other steels tested similarly, fractured at a fraction of the yield strength at much higher temperatures. (auth)

6441 STUDY OF THE RECRYSTALLIZATION PROCESS OF IRON BY MEANS OF RADIOACTIVE ISOTOPES. S. Z. Bokshteĭn, M. A. Gubareva, S. T. Kushkin, and L. M. Moroz. Zavodskaya Lab. 26, 1111-14(1960). (In Russian)

Previous studies demonstrated the correlation between the free energy of grain growth and the activation energy of self-diffusion in liquid iron. This problem was further investigated by studying the behavior of the iron grain boundary atoms during plastic deformation and subsequent recrystallization, using a method based on autoradiography of the radioactive Fe^{59} atoms introduced into the system and supplemented by data obtained by x-ray diffraction and chemical and microstructural analyses. In studying the diffusion process, electropolishing and autoradiographic tests were alternated. It was established that relatively high- and also relatively low-level deformations did not cause a substantial change in the structure after a double recrystallization and an $\alpha \rightarrow \gamma$ transformation process. In the absence of recrystallization, the plastic deformation process is accompanied by a considerable transfer of atoms at the grain boundaries and by a novel, nondiffusion type grain-growth mechanism. (TTT)

6442 DIFFUSE COATINGS ON IRON AND STEEL. (Diffusionye Pokrytiya na Zheleze i Stali). N. S. Gorbunov. 172p. Translation of a Publication of Academy of Sciences, USSR, Moscow, 1958. (OTS-60-21148; PST Cat. No. 115). $1.75(OTS).

The physico-chemical principles of the formation of diffuse coatings, new methods of their application, and experimental results of investigations of the properties of the coatings obtained by these methods are discussed. The diffuse coatings formed by the elements in each group of the Periodic Table were investigated. (M.C.G.)

6443 HIGH-TEMPERATURE SEMICONDUCTORS FOR THERMOELECTRIC CONVERSION. S. W. Kurnick, R. L. Fitzpatrick, and J. F. Leavy (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Paper No. 1274-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 4p.

At the high end of the temperature scale (800 to 1600°K), new semiconductors are receiving emphasis in development. $CeS_{1.33-1.50}$ is such a semiconductor, and at present the material is sufficiently optimized to give zT's of 0.1 and above. The study of this semiconductor (n-type) is implemented by the study of a p-type semiconductor $ThS_{1.71-1.76}$. Progress to date on these materials is discussed. The measurement of the thermal conductivity of Ce−S at high temperatures, usually very difficult to make, is made by a small-area-contact technique developed at General Atomic. (auth)

6444 IMPROVEMENTS IN OR RELATING TO PROCESSES FOR THE PREPARATION OF CARBON BASE MATERIALS AND NUCLEAR REACTORS INCLUDING SUCH MATERIALS. (to N. V. de Bataafsche Petroleum Maatschappij). British Patent 851,548. Oct. 19, 1960.

Carbon having good properties for use as reactor moderator, reflector, or heat carrier material may be manufactured by mixing or impregnating graphite-type carbon with a deuterated heavy hydrocarbon, especially of the polynaphthenic type, and homogenizing with high-energy radiation. Various ways of impregnating and shaping the carbon are outlined. (D.L.C.)

6445 IMPROVEMENTS IN OR RELATING TO PROCESSES FOR THE PREPARATION OF CARBON BASE MATERIALS AND NUCLEAR REACTORS INCLUDING SUCH MATERIALS. (to N. V. de Bataafsche Petroleum Maatschappij). British Patent 852,600. Oct. 26, 1960.

Carbon of superior moderating properties, low neutron absorption, and good shape-retaining properties may be manufactured by adding a deuterated heavy aromatic polycyclic hydrocarbon to the carbon and homogenizing by thermal or irradiation treatment. Various ways of manufacture in the above manner are outlined. (D.L.C.)

6446 URANIUM−TITANIUM−NIOBIUM ALLOYS. (to U.S. Atomic Energy Commission). British Patent 854,808. Nov. 23, 1960.

Water corrosion data and methods of preparation are given for U−Ti−Nb alloys which have improved corrosion resistance over U−Ti alloys. Suitable alloys contain 2.5 to 6 wt. % titanium and 1 to 2 wt. % niobium, the bal-

ance being uranium; the best alloy for reactor use contains 3 wt. % titanium and 15 wt. % niobium. (D.L.C.)

Radiation Effects

6447 (CRMet-983) EFFECT OF NEUTRON IRRADIATION ON THE TENSILE AND IMPACT PROPERTIES OF M257 (A SINTERED ALUMINUM ALLOY) AND M486 (AN ATOMIZED POWDER ALLOY OF ALUMINUM). L. M. Howe (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1960. 12p. (AECL-1146). AECL.

Neutron irradiation of a sintered aluminum alloy and an atomized powder alloy of aluminum had no significant effects on the tensile or impact strength under test conditions. (auth)

6448 (NDA-2116-7) SPONGE FUEL EVALUATION. Quarterly Technical Report for the Period Ending June 30, 1960. J. M. McKee (Nuclear Development Corp. of America, White Plains, N. Y.). Aug. 15, 1960. 8p. Project No. III. Contract AT(30-1)-2303. OTS.

Two sponge fuel specimens of unalloyed 3% enriched uranium shot are being irradiated in capsule NDA-4-2. Irradiation of the capsule continued without incident, reaching 0.44 at. % burn-up at the end of the quarter. (W.L.H.)

6449 (NP-9141) ZUR BILDUNG VON DEFEKT-KASKADEN IN KRISTALLEN BEIM BESCHUSS MIT ENERGIEREICHEN KORPUSKULARSTRAHLEN. (Formation of Defect Cascades by Bombardment with Energetic Particle Radiation). Chr. Lehmann (Aachen. Technische Hochschule and Gesellschaft zur Förderung der Kernphysikalischen Forschung, [Düsseldorf]). [1959?]. 98p.

A study was made of the defect cascades (cascades of equal numbers of interlattice atoms and vacancies) produced by high-energy radiations in crystals. For this purpose a calculation was made of the average number of defects per displaced primary atom $\bar{n}(E)$ in a cascade of which the deviation $S = (\bar{n}^2 - \bar{n}^2)/\bar{n}^2$, as a function of the energy E of the primary atom. An investigation was then made of the dependence of $\bar{n}$ and S on the model for bonding of the atom in the lattice, on assumptions concerning the manner of release of atoms from their lattice positions, and on the laws of atomic collisions. The displacement of atoms from their lattice positions is impeded by neighboring atoms. The effect of this anisotropy can be treated as an escape probability. For energies below a threshold E_d (25 ev in metals) this is zero and above an energy limit E'_d it is one. As functions for the escape probability, the vertical step $E_d = E'_d$, the sloping step, and the double step were chosen. The two-body collisions between atoms can be described by collision spectra. In the calculations a hard-sphere spectrum, a linear spectrum, an exponential spectrum, a box-shaped spectrum (modified hard sphere), and a spectrum with a step profile were brought in. The important results of the case treated are for large defect numbers ($\bar{n} >> 1$): $\bar{n}$ and S depend practically not at all on the two bonding models used; $\bar{n}$ varies strongly with the energy limit E'_d of the escape probability, and on the other hand, not so strongly with the course of the escape probability; $\bar{n}$ and S are largely independent of the shape of the collision spectrum. The lack of influence of the collision spectrum leads to the conclusion that in nearly all practical cases one comes out mathematically with a very satisfactory approximation to the hard sphere. The deviation S is so slight that one must always speak of a sharp $\bar{n}$ value for large defect numbers. (tr-auth)

6450 (NP-9665) DIELECTRICS UNDER NUCLEAR ENVIRONMENT, WA 8937-TASK NO. 65.10.12. E. A. Blasi (Lockheed Aircraft Corp. Missile System Div., [Sunnyvale, Calif.]). Sept. 9, 1959. 5p.

A study was made to determine the changes in the dielectric properties of dielectric materials while they are exposed to nuclear radiation. It was found that neither Teflon, polystyrene, or Rexolite 1422 showed any significant change in dielectric properties while subjected to irradiation. (W.L.H.)

6451 (NP-9692) L'INFLUENCE D'IRRADIATION AUX NEUTRONS RAPIDES SUR LE LUMINOPHORE ZnS-Mn (10^{-4}). (Effects of Fast-Neutron Irradiation on ZnS-Mn Phosphor (10^{-4}). Report No. 164/XIII. P. Jaszczyn (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Aug. 1960. 9p.

At +20°C, −70°C, and −180°C the intensity of the blue and orange photoluminescence of ZnS(Mn) samples (Mn concentration = 10^{-4}) previously irradiated in an atomic reactor was measured. At low temperatures, the effects of infrared radiation on the luminescence were measured. (tr-auth)

6452 (TID-11310) BASIC RADIATION DAMAGE STUDIES. Progress Report for Period December 15, 1959-December 15, 1960. (Purdue Univ., Lafayette, Ind.). Dec. 30, 1960. 9p. Contract AT(11-1)-125. OTS.

A study of the effect of absorbed hydrogen on low-energy electron bombardment was made. Low-temperature annealing of irradiated n-type germanium was studied. Further studies were made of the carrier trapping effects that are observed in irradiated p-type germanium at liquid nitrogen temperature. A theoretical study is being made of the electronic structure of the E-center in irradiated silicon. (W.L.H.)

6453 (TID-11311) STORED ENERGY RELEASE BELOW 80°K IN DEUTERON IRRADIATED COPPER. A. V. Granato and T. G. Nilan (Illinois. Univ., Urbana). [1959?]. 9p. OTS.

An experiment was performed to measure the energy released from copper after 11-Mev deuteron irradiation. Results are discussed, and it is concluded that the close-pair model of radiation damage at low temperatures is applicable. (J.R.D.)

6454 EFFECTS OF NUCLEAR RADIATION ON THE DIELECTRIC PARAMETERS OF INSULATING MATERIALS. K. A. Vodop'yanov, B. I. Vorozhtsov, M. D. Lavrov, E. S. Nesmelova, and G. I. Potakhova. Atomnaya Energ. 9, 498-500(1960) Dec. (In Russian)

The temperature and frequency characteristics of dielectric penetrability and angle of dielectric losses in polyethylene, fluoroplastic-4, and product-10 (mixture of polystyrene and vinyl naphthalene) were studied before and after exposure to γ rays at 400 to 1200 r/min to a total dosage of 2000 to 100,000 r. The frequency dependence of the angle of losses and dielectric penetrability are almost unchanged at 50,000 r, while at 10^7 Hertz frequency and 100,000 r the angle of losses is slightly larger for fluoroplastic-4 but unchanged for polyethylene and product-10. The angle of loss exhibits the same independence of irradiation at various temperatures. The angle of loss and dielectric penetrability was plotted for vitritextolite, resins, and paliomide-68. It was found that in most organic solids the angle of loss due to irradiation increased at low frequencies and decreased with rising frequencies. It is postulated that the variations of the angles of loss in

organic dielectrics are determined by the mechanism of dielectric penetrability. (R.V.J.)

6455 DEGRADATION AND CROSSLINKING IN IRRADIATED POLYAMIDES AND THE EFFECT OF OXYGEN DIFFUSION. Joseph Zimmerman (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). J. Polymer Sci. 46, 151-62(1960) Sept.

The changes in relative viscosity which occur when nylon 66 is irradiated with 2-Mev electrons under an oxygen-free atmosphere under various conditions were observed. A mechanism is proposed which reconciles all of these observations; and on the basis of this postulated mechanism, yields of chain breaks and crosslinks are calculated. The effect of the presence of a small concentration of a vinyl monomer (acrylic acid) in the polymer during irradiation on degradation and crosslinking is also considered. The rate of penetration of oxygen into irradiated polyamides was measured. There is a marked reduction in penetration rate which results from the presence of free radicals in the fiber and the irreversible reaction that results. The data are treated by an approximate diffusion equation, and estimates of true diffusion coefficients are given. The effect of filament diameter on the extent of degradation which occurs when fibers of nylon 66 are irradiated and then exposed to air was investigated. The marked dependence of degradation on fiber thickness is related qualitatively to the data on rate of oxygen penetration. (auth)

6456 THE ANISOTROPY OF OPTICAL ABSORPTION INDUCED IN SAPPHIRE BY NEUTRON AND ELECTRON IRRADIATION. E. W. J. Mitchell, J. D. Rigden, and P. D. Townsend (University, Reading, Eng.). Phil. Mag. (8) 5, 1013-27(1960) Oct.

Measurements were made of the anisotropy of the optical absorption induced by neutron and electron irradiation. Some of the measurements were made with a six-plate fluorite polarizer, with an efficiency of 65% at 2500 A, and which could be used at shorter wavelengths than a Glan–Thomson prism. In the spectrum induced by neutron irradiation, bands are resolved at −185°C at 1.9, 2.2, 2.8, 3.5, 4.1, 4.8, and 6.1 ev, the latter being measured both with a quartz spectrophotometer and a fluorite vacuum spectrograph. The 6.1-ev band was found to be isotropic but the 2.8-, 3.5-, 4.1-, and 4.8-ev bands were anisotropic, having parallel to perpendicular ratios greater than 1. The anisotropy measurements reveal the presence of a band of opposite anisotropy at 5.3 ev. In order to account for the complete shape of the spectrum of the anisotropic ratio it is necessary to assume the presence of other bands having the same anisotropy as the 5.3-ev band. The 5.3-ev band did not appear in the electron irradiated specimens, although both the 4.8- ($\mu_{\parallel} < \mu_{\perp}$) and 6.1-ev (isotropic) bands were found. Possible models for these two centers are discussed. The rate of decrease of absorption with heat treatment was measured for temperatures to 500°C and is compared with the rate of recovery of the neutron-induced expansion studied by Martin. (auth)

6457 THE ANNEALING OF ELECTRON IRRADIATION DAMAGE IN GRAPHITE. W. N. Reynolds and P. R. Goggin. Appendix: GALVANOMAGNETIC FORMULAE FOR AN OVERLAPPING CYLINDRICAL TWO-BAND MODEL OF GRAPHITE. D. F. Johnston (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8) 5, 1049-58(1960) Oct.

Samples of pure artificial graphite were irradiated with electrons at 79°K, and a study made of the annealing characteristics of the changes in electrical conductivity, Hall effect, and magneto-resistance. All three quantities show an anomalous annealing range below 120°K, and a simplified band theory calculation indicates that the concentration of both electrons and positive holes increases during irradiation and in the anomalous annealing range. (auth)

6458 THERMAL WAVES IN IRRADIATED GRAPHITE. D. C. Cooper and N. E. Hoskin (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Quart. J. Mech. and Appl. Math. 12, 393-406(1959) Nov.

The mathematical formulation of a problem in the release of Wigner energy in a graphite bar of variable specific heat and thermal conductivity is presented. The results of six such illustrative computations, obtained with the help of the IBM 704 computer, are given to show the formation and motion of a thermal wave down the graphite bar. (auth)

6459 IMPROVEMENTS IN OR RELATING TO THE IRRADIATION TREATMENT OF OBJECTS CONSISTING OF SYNTHETIC LINEAR POLYMERISATION OR POLYCONDENSATION PRODUCTS. (to N. V. Onderzoekingsinstituut Research). British Patent 852,954. Nov. 2, 1960.

The method for improving by irradiation the heat resistance and reducing the tendency to shrink at high temperatures of polymerization or polycondensation products is improved (the reduction in the shrinking tension is increased further) by slightly swelling the objects to a content of less than 25 wt. % of the swelling agent and then irradiating. Materials which may be treated in this way include polyvinyl compounds, polyethylene, polyamides, polyurethanes, and polyesters. Swelling agents which may be used are water, alcohols, biphenyl, chlorobenzenes, etc. An example of this method is given in which a polyhexa-methylene adipamide thread was swelled in water and irradiated with electrons to a total dose of 5×10^6 rep. (D.L.C.)

PHYSICS

General and Miscellaneous

6460 (AD-125194) THE FEASIBILITY OF THE NUCLEAR POWERED ION PROPELLED SPACE VESSEL (thesis). Donald McRae Mixson (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Mar. 1957. 96p.

A feasibility study is presented of the application of nuclear power as a prime energy source for an ion rocket capable of reaching Mars and returning. Calculations show that a 100-ton ship is feasible, using cesium fuel and taking 114 days. A spherical liquid-metal fuel reactor is indicated, and a two-group calculation shows that a minimum fuel enrichment of 0.3% is required. The 300-ton vehicle is feasible and within the limits of present technology. (T.R.H.)

6461 (AD-237019) INTERACTION OF ELECTRON AND ION BEAMS WITH METASTABLE SUBSTANCES. Final Report. Charles J. Cook and William J. Fredericks (Stanford Research Inst., Menlo Park, Calif.). Mar. 15, 1960. 139p. SRI Project No. SU-2741. Contract DA-44-009-ENG-3783.

A symmetrical acceleration-deceleration device is described that produces focused beams of electrons with en-

ergies of 0.2 to several hundred electron volts. Slow electron absorption coefficients were determined for pure and nonstoichiometric KBr and KCl crystals, pure and irradiated MgO, and α-lead azide. (C.J.G.)

6462 (AD-238430) CRATERING FROM HIGH EXPLOSIVE CHARGES—COMPENDIUM OF CRATER DATA. Technical Report No. 2-547. Report No. 1. (Waterways Experiment Station, Vicksburg, Miss.). May 1960. 114p.

All available high-explosive cratering data from test series in various media are compiled in narrative and tabular form. The data are grouped according to data obtained from cratering in soils, frozen ground, rock, ice, and snow. (W.L.H.)

6463 (AD-240333) KINETIC STUDY OF ROCKET EXHAUST GASES. Progress Report No. 1. Richard A. Rossi and John Feduchak (Cross-Malaker Labs., Inc., Mountainside, N. J.). June 1960. 70p. DA Project No. TB 5-20. Contract DA-30-069-ORD-2918. (CM-103-1). OTS.

Ionization occurring in high-temperature gases is investigated through the use of the Saha Relationship. For a model gas having an ionization potential of 13 ev, the ionization fraction and number of free electrons per cm^3 are presented. Methods of increasing the degree of exhaust gas ionization are covered. The effect of adding an easily ionized element to the exhaust gases is demonstrated to be highly desirable. At a given temperature, approximately 1 part of potassium per 10^6 parts of the model gas produces the equivalent number of free electrons. A compilation of a number of possible ionizable additives is included. The effect of electron-ion recombination is discussed. It is shown that within approximately one second 90% of the maximum operating level of an energy device would be attained. A compilation of electron-ion recombination coefficients is included. Basic equations governing the physical system are presented. In some cases simplifying assumptions have been applied to the more general equations. A discussion of required experimental parameters is presented in order to demonstrate the feasibility of an energy extracting device. A partial bibliography of material covering magnetohydrodynamics, plasma physics, and related fields is included. (auth)

6464 (AD-240488) SOME NON-EQUILIBRIUM PROPERTIES OF A BOSE SYSTEM OF HARD SPHERES AT EXTREMELY LOW TEMPERATURES. Technical Report No. 320. Tai Tsun Wu (Harvard Univ., Cambridge, Mass. Cruft Lab.). Apr. 25, 1960. 70p. Contract Nonr-1866(32).

The pseudopotential method is used to study a special type of flow for a Bose system of hard spheres. In the first-order approximation, the wave function of the entire system is assumed to be the product of identical single-particle wave functions, which in general are time-dependent. Such a flow is necessarily irrotational, and the single-particle wave function satisfies a Schrödinger equation with a nonlinear self-coupling term. On the basis of this equation of motion, the following properties of the Bose system are discussed: the effect of the rigid wall, the moment of inertia, the compressional wave, and a type of "vortex filament." In the second-order approximation, the wave function of the system is expressed in terms of two functions such that one of them describes the single-particle state suitable for most of the particles while the other one describes the pair excitations. The much more complicated equations of motion are found, but in this approximation the flow is no longer strictly irrotational. The compressional waves are also studied in the second-order approximation. (auth)

6465 (AD-240813) REVIEW OF THE ION ROCKET WITH EMPHASIS ON THE DUO-PLASMATRON SOURCE. Myron A. Hoffman, Richard J. Hayes, James M. Glassmeyer, and Charles A. Huebner (Massachusetts Inst. of Tech., Cambridge). June 6, 1960. 107p.

The problems associated with the development of a flyable ion engine are analyzed. After defining the range of applicability of the ion engine and its relation to the overall propulsion spectrum, the general problems that are common to other systems are discussed briefly. Attention is then focused on the more distinguishing features of ion propulsion and a detailed examination of the ion source, accelerator, and neutralization problems is presented. Particular emphasis is given to the complex operation of the Duo-Plasmatron ion source. In the development of the acceleration analysis, special attention is given to the axially symmetric accelerator designs that are distinguishing features of Duo-Plasmatron systems. Specific consideration is also accorded the subject of accelerate-decelerate systems in terms of interelectrode potentials. The analysis of space charge effects in unneutralized ion beams is followed by detailed development of the electron injection and charge exchange neutralization methods. In addition to providing an insight into the physics of ion propulsion theory, an attempt is made to achieve an understanding of the experimental difficulties of current industrial research programs; thus the reasons why there is an interest in ion propulsion today are presented along with a detailed appraisal of the developmental status of ion engine research. (auth)

6466 (AD-241254) THERMOELECTRIC MATERIALS. Bi-Monthly Progress Report No. 6 [for Period]: November 28, 1959 to January 28, 1960. R. G. Breckenridge, comp. (Union Carbide Corp. Parma Research Lab., Ohio). Feb. 15, 1960. 36p. Contract NObs-77066.

The new method for production of rare earth nitrides described previously was successfully used in the preparation of a series of these compounds. Samarium nitride demonstrated the best combination of chemical stability and reasonable semiconductor properties. The rectangular bar method for the measurement of thermal conductivity of electrical conductive materials was improved to the extent that it is becoming one of the more accurate methods available in the temperature range above 1000°K. Theoretical work on the electronic properties of graphite was carried to the point where it is possible to calculate the high temperature electrical resistivity and thermoelectric power of single crystals or well-ordered graphite filaments with good agreement with the experimental data available. An extensive review of vitreous electronic conductors is given. (W.D.M.)

6467 (AFOSR-TN-60-756) A STUDY OF THE THERMIONIC POINT FILAMENT ELECTRON GUN. Technical Report No. 18 [on] THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF THE ATOMIC PHENOMENA OCCURRING ON AND NEAR THE SURFACES OF SOLIDS. Malcolm Richard Specht (Cornell Univ., Ithaca, N. Y.). July 1, 1960. 92p. Contract AF 18(600)-674.

A study of thermionic point filament electron guns and their applications in electron microscopes and diffraction cameras is presented. Determinations of the brightness and diameter of the sources for these guns were made for various operating conditions. (J.R.D.)

6468 (ANL-6235) PHYSICS DIVISION SUMMARY REPORT. (Argonne National Lab., Ill.). Nov. 1960. 78p. Contract W-31-109-eng-38. OTS.

Preliminary results and data are given for eight experimental and theoretical nuclear physics projects under investigation. Those projects not reported are listed separately with a reference to the last issue in which each appeared. Separate abstracts were prepared for the eight activities. (For preceding period see ANL-6214.) (W.D.M.)

6469 (ANL-6235(p.10-15)) STOPPING POWER OF CARBON FOR Po^{210} ALPHA PARTICLES. S. Barkan (Argonne National Lab., Ill.).

The atomic stopping power of elemental carbon relative to air was determined by a direct measurement for Po^{210} α particles to within 1%. It was found to agree with the value obtained from Bragg's additive law. (auth)

6470 (ANL-6235(p.51-4)) SOLID-STATE RADIATION DETECTORS. T. H. Braid and J. T. Heinrich (Argonne National Lab., Ill.).

Solid-state detectors were developed which are suitable for dE/dx and total energy measurements on α particles up to at least 40 Mev in energy. (auth)

6471 (ANL-6235(p.55-60)) INVESTIGATION OF SCINTILLATORS. L. J. Basile, W. L. Buck, and A. Weinreb (Argonne National Lab., Ill.).

A modified arrangement of accelerating electrodes for the pulsed electron accelerator is described. The optical absorption by a thin polystyrene film was measured in the vacuum ultraviolet region. (auth)

6472 (DMIC-Memo-72) EMISSIVITY AND EMITTANCE—WHAT ARE THEY? W. D. Wood, H. W. Deem, and C. F. Lucks (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 10, 1960. 21p. (PB-161222). OTS.

A review of basic radiant-heat-transfer fundamentals, including a discussion of the radiation process, definitions of terms, the radiation laws, and some general relations based on these laws are presented. The information was collected for the use of scientists involved in space and missile technology and others. (J.R.D.)

6473 (GA-774) SOME CONSIDERATIONS OF THE BASIC PHYSICS OF THERMOELECTRIC EFFECTS. Werner B. Teutsch (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 12, 1959. 10p.

Presented at the Conference on Thermoelectricity sponsored by the Naval Research Lab., Washington, D. C., Sept. 3 and 4, 1958.

A general discussion of thermoelectric effects is presented. The considerations are presented without explicit reference or emphasis on any practical application. (J.R.D.)

6474 (GA-1038) THERMODYNAMIC AND TRANSPORT PROPERTIES OF GASEOUS CARBON DIOXIDE. L. H. Chen (General Dynamics Corp. Electric Boat Div., Groton, Conn.). Aug. 10, 1959. 159p. Contract AT(04-3)-187. OTS.

The thermodynamic and transport properties of gaseous CO_2 are presented. The properties were computed from the most recent data. The results are presented graphically with pressure and temperature as independent variables for convenience in engineering calculations. (J.R.D.)

6475 (GAMD-1619) THE (n,2n) EFFECT IN A BeO MODERATOR. A. J. Goodjohn and G. W. Hinman (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 23, 1960. 8p. Project No. 40. Contract AT(04-3)-187. (MGCR-RP-230). OTS.

Cross section data on the $Be^9(n,2n)$ reaction are presented and discussed to show that in an infinite homogeneous BeO moderated reactor with no appreciable moderation by other materials, the probability for (n,2n) reactions $E(n,2n) = 1.073$ and the net fast effect is 1.040. $E(n,2n)$ could be 0.014 larger if the reaction threshold was 1.7 Mev rather than 2.7 Mev. Aside from the uncertainty near the threshold the cross sections are sufficiently accurate to establish the fast effect to within ±0.75%. (T.R.H.)

6476 (HW-64866) NUCLEAR PHYSICS RESEARCH QUARTERLY REPORT [FOR] JANUARY, FEBRUARY, MARCH 1960. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 20, 1960. 151p. Contract AT(45-1)-1350. OTS.

Progress is indicated on various research activities in the fields of experimental nuclear physics, reactor physics, and physics of nuclear safety. Separate abstracts were prepared for the 14 sections of the report. (For preceding period see HW-63576. For subsequent period see HW-66215.) (W.D.M.)

6477 (HW-64866(p.8-23)) HIGH RESOLUTION NEUTRON REFLECTIVITY MEASUREMENTS ON SINGLE CRYSTALS. D. A. Kottwitz (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The purpose of the reflectivity measurements was to select crystals suitable for use as three-axis crystal spectrometer monochromators and analyzers. A secondary purpose was to obtain reflectivity data on the finally chosen crystals, so that quantitative predictions of spectrometer performance could be accurately made. The experimental set-up consisted of a parallel monochromatic beam of neutrons impinging on rotatable calcite single crystals that were large enough to intercept the whole beam. (W.D.M.)

6478 (HW-64866(p.24-54)) GROWTH OF ALUMINUM SINGLE CRYSTALS. W. J. Friesen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Two methods employed recently in attempts to grow aluminum single crystals from the melt, suitable as neutron monochromating crystals for neutron crystal spectrometers, and some of the results obtained are described. The perfection of the single crystals grown was studied from the standpoint of their ability to reflect neutrons and their use as neutron monochromators. (W.D.M.)

6479 (HW-64866(p.126-36)) LUTETIUM AS A SPECTRAL INDEX DETECTOR. L. C. Schmid and W. P. Stinson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-66319)

The ratio of the activities induced in lutetium by neutron capture has been shown to be a sensitive indicator of a spectral index that characterizes the Maxwellian distribution of neutron energies in a thermal column. The experimental techniques involved in γ counting of lutetium foils are described in detail, and γ spectra are shown. (W.D.M.)

6480 (JINR-D-545) AN INVESTIGATION OF PROPERTIES OF TRANSURANIC ELEMENTS BY USING A SUPERFLUID MODEL OF A NUCLEUS. V. G. Solov'ev (Soloviev) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 23p.

A study is presented of the properties of the strongly-deformed transuranic elements using a superfluid model of a nucleus. As a self-consistent field the Nilsson potential, with energy levels slightly corrected in accordance with the experimental data, is used. Under the assumption of the adiabatic approximation the single-particle levels of both odd and even-even nuclei and the pairing energies are calculated. The corrections to β- and γ-transition probabilities are made. (auth)

6481 (JINR-D-559) INVESTIGATION OF MU-MESIC ATOM PARAMAGNETISM. L. B. Egorov, G. V. Zhuravlev, A. E. Ignatenko, Syang-ming Li, M. G. Petrashku, and D. Chultem (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 16p.

On the basis of the electron asymmetry measurements of (mu-e) decay, the nature of paramagnetism of various mesic atoms was studied. The results of experiments show that in dielectrics, diamagnetic and weak-paramagnetic normal metals paramagnetism of mesic atoms is caused by the magnetic moment of the muon; and in paramagnetic transition metals, lanthanides, and actinides, it is caused by the magnetic moment of the electron shell and that of the meson. The possibility of using polarized mesons as a means of investigating magnetic properties of hydrides of transition metals, actinides, and lanthanides, the atoms of which have zero spin states, was established. (auth)

6482 (MURA-591) RELAXATION CALCULATION OF INTEGRAL SCALING MAGNETIC FIELDS PRODUCED BY DISTRIBUTED CURRENTS. S. C. Snowdon (Midwestern Universities Research Assn., Madison, Wis.). Oct. 17, 1960. 12p. Contract AT(11-1)-384. OTS.

Algorisms are developed for the solution of an integral scaling magnetostatic problem. The particular problem adapted to relaxation techniques consists of distributed pole-face windings located in spiral grooves periodically connected in radial gaps to form complete current loops. The potentials on the poles thus excited are not graded differentially across the pole face. (auth)

6483 (NAA-SR-Memo-5524) TEMPERATURE DISTRIBUTION IN OUTER TUBE OF AN IRRADIATION CAPSULE CONTAINING CENTERING FINS IN THE GAS ANNULUS. Matthew King (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 21, 1960. 26p. OTS.

Investigations were made to determine the temperature distribution in the outer tube of an irradiation capsule that has centering fins of various widths and heights in the gas annulus adjacent to the outer tube. Studies also were made to determine ~ the variation of thermal resistance with fin width and fin height. Nine different fin configurations in a representative double-walled capsule were studied using a digital heat-transfer code. The temperature distributions in the outer tube are tabulated. (W.L.H.)

6484 (NASA-TN-D-617) AN INVESTIGATION OF A PHOTOGRAPHIC TECHNIQUE OF MEASURING HIGH SURFACE TEMPERATURES. James H. Siviter, Jr. and H. Kurt Strass (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). Nov. 1960. 16p. OTS.

A photographic method of determining elevated temperatures of surfaces is presented. The investigation gives a simplified technique of calibrating a photographic emulsion. The lower limit of applicability is about 1400°F when conventional cameras and emulsions are used. The upper limit is determined by the calibration technique and the accuracy required. (auth)

6485 (NBS-6714) ATOMIC BEAM FREQUENCY STANDARDS. R. C. Mockler, R. E. Beehler, and C. S. Snider (National Bureau of Standards. Boulder Labs., Boulder, Colo.). Aug. 12, 1960. 64p. NBS Project 8440-12-84104.

A general qualitative description of atomic beam devices is given with particular emphasis on cesium atomic frequency standards. The various uncertainties in frequency measurements are discussed, including the effects of the uniform C field, the effect of a phase difference between the two oscillating fields that excite the atomic transition, and the effect of exciting an atomic transition with signals that are not monochromatic. The two cesium beam devices constructed at the National Bureau of Standards are described in some detail. The various tests are described for determining the uncertainties in the frequency measurements. The results of these tests are given. The accuracy of these two quite dissimilar machines is considered to be $\pm 1.7 \times 10^{-11}$, and the precision of measurement is 2×10^{-12}. The latter figure represents the standard deviation of the mean for measurement times of a few hours or about 100 separate measurements. (auth)

6486 (NP-9344(Vol.II)) SUMMARY OF TECHNICAL REPORTS, JANUARY–JUNE 1959. VOL. II. SPACE MECHANICS PLASMA PHYSICS ARC RESEARCH LIFE SUPPORT (General Electric Co. Aerosciences Lab., Philadelphia). 376p. Contract AF04(647)-269. Includes reprints: HYDRODYNAMIC IMPACT. V. G. Szebehely. Appl. Mechanics Revs. 12, No. 5, 4p. (1959). HEAT PROTECTION FOR RE-ENTRY VEHICLES. Norris F. Dow. Astronautics 4, 4p. (1959) Mar.

A collection of selected research papers prepared in the period Jan.-June 1959 is presented. Topics covered include problem of two centers of gravitation, radiation effects on materials, hydrodynamic impact, meteoroid bumpers, space vehicle structures, orbit computations, reentry vehicle heating, plasma generators, air-carbon mixtures, air arcs, electron concentrations, and life support systems. (W.D.M.)

6487 (NP-9429) ENERGY LOSS AND RANGE OF CHARGED PARTICLES IN COMPOUNDS. Research Report. Werner Brandt (du Pont de Nemours (E. I.) & Co. Radiation Physics Lab., Wilmington, Del.). July 1960. 43p.

In this revised and extended edition of the tabulations of 1957 (cf. United States Atomic Energy Commission Nuclear Data Tables 1959, p.35), the calculated energy loss and range of heavy charged particles, electrons, and positrons are tabulated for particle energies, E/M_0c^2, from $5 \cdot 10^{-4}$ to 20 for the following substances: 12 organic plastics, 8 bubble-chamber liquids, standard nuclear emulsion, water, wet muscle tissue, bone tissue, cadmium, aluminum, and copper. (auth)

6488 (NP-9510) THE REDUCTION OF GAMMA SPECTRAL DATA FROM A 100-CHANNEL PULSE HEIGHT ANALYZER — 704 PROGRAM REPORT. J. W. Nostrand, Jr., A. J. Favale, and H. Winton (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Apr. 1960. 29p. (RM-175).

The program described is designed to reduce the γ spectral data of an activated metal alloy measured with a 100-channel pulse-height analyzer. This program can handle up to 15 spectra taken at time $t_1, t_2, \ldots t_{15}$ for a particular alloy sample and will calculate the γ activity of

as many as 10 photopeaks in each spectrum. The general method of analyzing the photopeaks is done by establishing a base line joining the minimum points on either side of a peak. The number of counts in a peak are then summed and the total γ activity is calculated. The γ activities are used as input to a least squares routine that analyzes the photopeak decay. The least squares routine can be used independently or with another method of determining photopeak γ activity. (auth)

6489 (NP-9522) QUARTERLY PROGRESS REPORT NO. 38. (Massachusetts Inst. of Tech., Cambridge. Solid-State and Molecular Theory Group). Oct. 15, 1960. 97p. Contract Nonr-1841(34).

A molecular orbital treatment is offered for the ring of six H atoms. The magnetic properties of a linear chain of N monovalent atoms with periodic boundary conditions is considered, with attention limited to a hydrogenic system in which a single electron is associated with each atom. In a general study of electronic structure of C_2H_2, the SCF wave functions for the linear molecule and two trans-bent configurations (C-H bonds bent 30 and 60°) were obtained. A configuration interaction study of the electronic states of H_2O is briefly reported. The computation of the 29 additional points in the Brillouin zone of bcc iron was finished. Using Slater's augmented plane wave method, solutions of the periodic potential in face-centered nickel were obtained. Work on interpretation of $K_3Fe(CN)_6$ absorption spectra continued. Diagmagnetic shielding of nuclei in metals was also studied. Current theory regarding the interaction of acoustic and electromagnetic waves in crystals is outlined in simple form. One-electron orbitals were obtained by applying the variation principle to the two-configuration $1s^22s^2 - 1s^22p^2$ approximation to the ^1S ground state of four-electron ions (Be through Ne^{6+}). Study of information processing machines with lamellar storage continued with progress reported on string transformation procedures, lamellar storage devices, recursively structured machines, and biochemical gating. (See also NP-8987). (T.R.H.)

6490 (NP-9525) LECTURES ON STATISTICAL MECHANICS OF NONEQUILIBRIUM PHENOMENA. Leon Van Hove (Utrecht. Rijksuniversiteit. Instituut voor Theoretische Fysică). [195?]. 35p.

[Extract from] "La Théorie des Gaz Neutres et Ionisés."

An analysis is made of the approach to equilibrium of nonequilibrium systems and behavior under external forces which prevents reaching equilibrium. A physical system consisting of electrons and heavy particles and neutral or ionized atoms is assumed, with emphasis on electric conductivity. Some simplifying assumptions are made: overall electrical neutrality, neglect of effects of electrons and external fields on motions of atoms, electron-atom interaction represented by finite potential at finite range, electron-electron interaction is neglected, and atoms are treated as forming an ideal gas. The topics discussed include: Boltzmann equation and electric conductivity, time evolution of the system in terms of probabilities (Pauli equation), derivation of Boltzmann equation from Pauli equation, criticism of random assumption, the conductivity tensor expressed in terms of an equilibrium correlation, equivalence of the two methods of determination of the conductivity tensor, derivation of Pauli equation, the equation for $X_{ll'}(\alpha\alpha_0)$, reduction of generalized Pauli equation for small W_E, and weak coupling and low-density gases. (T.R.H.)

6491 (NP-9699) SPECTRAL ANALYSIS BY THE POWDER SIFTING METHOD. PART II. THE EFFECT OF ALKALIS HALOGENIDES ON EXCITATION. (Analiza Spektralna Metoda Przesypu. II. Wpływ Halogenków Potascowców na Wzbudzenie). Report No. 173/VIII. J. Czakow (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Sept. 1960. 21p.

The investigations concerned the effect of alkalies halogenides on excitation of vanadium and were made by measuring intensity relations between the lines V II, 3110.7 A, and V I, 3185.4 A. The curve of the relation between the $A_{V\,II}/A_{V\,I}$ ratio and the halogenides of the given alkali metal proved to have an irregular shape. The intensities of the arc and spark lines of vanadium were increased upon addition of small amounts of some alkali metal halogenides. The effect of halogenides (anion) in combination with alkali metal can be notably diminished by the use of a suitable internal standard, which proved indispensable for quantitative determinations by this method. (auth)

6492 (NYO-2960) NEW METHODS OF SPECTROSCOPY APPLIED TO THE NUCLEAR 1-p SHELL (thesis). Daniel S. Koltun (Princeton Univ., N. J.). Nov. 1960. 172p. Contract AT(30-1)-937. OTS.

The intermediate coupling shell model for nuclei is considered in terms of the classification of states, introduced by Elliott, according to the irreducible representations of the unitary unimodular group in three dimensions, SU_3. The properties of this group are used to produce the approximate spectrum of a long-range two-body central potential, without exchange, acting within an oscillator shell. When specialized to the 1-p shell, a more general central interaction, including exchange forces, is shown to be approximately diagonal in the chosen representation, and its approximate spectrum is computed. A method is demonstrated for calculating the matrix elements of a single-particle spin-orbit force in the representation, using the generating functions of the group, SU_3. The intermediate coupling energy spectra of the nuclei of the 1-p shell are then calculated to first or second order in perturbation theory. The relation of the perturbation wave functions to the functions considered by Kurath and Picman in their treatment of the 1-p shell is discussed. (auth)

6493 (NYO-9373) LONG RANGE CORRELATIONS IN A CLOSED SYSTEM WITH APPLICATIONS TO NONUNIFORM FLUIDS. J. L. Lebowitz and J. K. Percus (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Oct. 1, 1960. 65p. Contract AT(30-1)-1480. OTS.

The corrections to the representation of the joint distribution of q + l particles, n_{q+l}, by the product $n_q n_l$ for large separation between the sets of q and l particles were investigated. For a system in which there exists a "finite correlation length," the 1/N correction term to the simple product is found explicitly, where N is the number of particles in the system. When q + l is equal to two, this expression reduces to that familiar from the Ornstein-Zernike relations for scattering of light from a fluid. In a uniform gas, the derivation also yields the complete 1/N dependence of equilibrium distributions. The result on the asymptotic form is then used to determine the low-order distribution functions for an equilibrium system of varying density, as well as for a nonequilibrium system represented by a local-equilibrium ensemble. These distribution functions are shown to be governed by the temperature and density in the vicinity of the molecules considered. It is found as expected that the two-body distribution function coincides, to within quadratic terms in the gradients, with its equilibrium value for a uniform system at the temperature and

density of the midpoint. For the higher-order distributions, correction terms linear in the gradients are found. (auth)

6494 (NYO-9434) STABILITY OF PHOSPHORS TO BETA RADIATION. W. P. Senett, K. Diehl, and R. Wright (Associated Nucleonics, Inc., Garden City, N. Y.). June 24, 1960. 182p. Contract AT(30-1)-2292. (AN-121). OTS.

Results of a study on the stability of phosphors under high-energy β radiation are presented. Irradiations were accomplished using Van de Graaff and Cockcroft-Walton accelerators in air and in vacuum and exposure to Kr^{85} and Pm^{147}. A theory of the cumulative effect of radiation on luminescence was worked out based on the simplest model which might be adequate. (W.D.M.)

6495 (ORNL-3016(p.234)) ELECTRON CASCADES: STATUS REPORT. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

The study of high-energy electron-photon cascades, a knowledge of which is necessary to design of efficient shielding for high-energy particle accelerators, was continued. A Monte Carlo calculation, expected to supply all data of interest, is being prepared for automatic computer solution. Codes for determining the requisite cross sections, as well as random selection techniques for determining scattering angles from differential cross sections, are complete. Final assembly of the calculation is in progress. (auth)

6496 (ORNL-3016(p.235-41)) CALCULATION OF THE DIFFERENTIAL INELASTIC CROSS SECTION FOR COMPLEX NUCLEI. H. Bertini and C. D. Zerby (Oak Ridge National Lab., Tenn.).

A program is in progress to calculate the differential energy and angular cross sections for the emission of particles from complex nuclei when the latter are bombarded by pions or nucleons in the energy range from 50 Mev to 30 Bev. These cross sections are needed for the design of shields for high-energy accelerators and rocket vehicles. The lower-energy phase of the program (incident energy range from 50 to 300 Mev) is nearly complete. Some initial results are given and compared with available experimental data. (auth)

6497 (ORNL-3016(p.254-7)) GAMMA-RAY RESPONSE OF LARGE NAi(Tl) CRYSTALS. G. T. Chapman and T. A. Love (Oak Ridge National Lab., Tenn.).

The investigations of the γ response functions of a composite 8-in.-diameter by 8-in.-long NaI(Tl) crystal at the Bulk Shielding Facility were continued. Experimental spectra from Cs^{137} and Na^{24} sources were measured and compared with calculated spectra developed by Monte Carlo codes. The results were encouraging, but additional study of interface effects, reflectors, and background effects is desirable. (auth)

6498 (ORNL-3016(p.257-63)) THE EFFECTS OF SCINTILLATOR DIMENSIONS ON PULSE-HEIGHT SPECTRA ESTIMATED BY MONTE CARLO FOR LARGE NaI CRYSTALS. R. W. Peelle (Oak Ridge National Lab., Tenn.).

An IBM 704 Monte Carlo program was employed to calculate the pulse-height spectra for large NaI crystals differing in shape, diameter, length, and in whether axial wells had been included. Variations were made about a 9-in.-diameter by 10-in.-long crystal, chosen as a standard of comparison. The results clearly demonstrate that a certain degree of control over the photofraction and the shape of the tail spectrum may be achieved by care in the choice of crystal dimensions. (auth)

6499 (ORNL-3016(p.267-9)) EXPERIMENTAL DETERMINATION OF FLUX DEPRESSION AND OTHER CORRECTIONS FOR GOLD FOILS EXPOSED IN WATER. W. Zobel (Oak Ridge National Lab., Tenn.).

Work was continued on the experimental determination of a correction factor to be applied to thermal neutron flux measurements with thin gold foils. Results are presented as a plot of correction factor, ϕ_0/ϕ, as a function of foil thickness. Comparison with various calculational approaches to the problem indicates best agreement with recent work of Dalton and Osborn. (auth)

6500 (ORNL-3016(p.269-75)) CALCULATION OF PULSE-HEIGHT RESPONSE FUNCTIONS FOR GAMMA-RAY SCINTILLATION COUNTERS. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

The IBM 704 Monte Carlo codes for the calculation of the pulse-height response functions for NaI, CsI, and xylene γ scintillation detectors were completed with the addition of means for including secondary bremsstrahlung and annihilation radiation. The codes, plus complete operating instructions, were prepared and are now available to those interested. Comparisons of the results of the NaI code with experimental spectra show excellent agreement when allowance is made for background effects in the experimental spectra. (auth)

6501 (ORNL-3016(p.289-93)) THE DISTRIBUTION IN ENERGY OF ALPHA-TRITON PAIRS RESULTING FROM NEUTRON BOMBARDMENT OF LITHIUM FLUORIDE. F. S. Alsmiller (Oak Ridge National Lab., Tenn.).

The use of paired silicon-gold surface barrier counters (with an intervening Li^6F layer) to record the sum of the energies of the triton and α particle produced in an $Li^6(n,\alpha)T$ reaction as a measure of the incident neutron energy has been described in a previous paper. The problem of calculating the shape and width of the distribution in total energy of the pairs reaching the silicon was investigated and some preliminary results were obtained. (auth)

6502 (ORNL-3016(p.293-6)) LIGHT OUTPUT OF CsI(Tl) UNDER EXCITATION BY GAMMA RAYS. R. Gwin and R. B. Murray (Oak Ridge National Lab., Tenn.).

A series of experiments investigating the light output of CsI(Tl) under excitation by monoenergetic γ rays was essentially completed. Results from a range of γ rays from 10 kev to 2.6 Mev were obtained and demonstrated that the light output of CsI(Tl) was not a linear function of the energy of the incident γ ray. The magnitude of the departure from linearity was measured for the crystal employed. The data will permit a calculation of light output per unit energy for electrons by the methods of Zerby et al. (auth)

6503 (ORNL-3016(p.297-301)) COMPARISON OF CALCULATIONS OF SCINTILLATION-COUNTER RESPONSE FUNCTIONS FOR CsI WITH NaI CALCULATIONS AND CsI EXPERIMENTS. H. S. Moran and C. D. Zerby (Oak Ridge National Lab., Tenn.).

The IBM 704 codes of Zerby and Moran were used to compare the responses of CsI and NaI to 0.662-, 1.368-, 2.754-, and 8.0-Mev γ rays. The calculated response of CsI to 0.662-Mev (Cs^{137}) and 1.368- and 2.754-Mev (Na^{24}) γ rays was also compared with experimental results. It was concluded that the advantages of decreased size and weight offered by CsI over NaI may be offset by increased cost. It was also concluded that the comparisons of calculations vs. experiment validate the usefulness of the codes. (auth)

6504 (ORNL-3016(p.302-8)) INTRINSIC LINE WIDTH IN NaI(Tl) GAMMA-RAY SPECTROMETERS. C. D. Zerby, A. Meyer, and R. B. Murray (Oak Ridge National Lab., Tenn.).

In the use of NaI(Tl) scintillation crystals for γ spectroscopy, it is important to achieve a minimum line width in the pulse-height spectrum resulting from monoenergetic γ rays. The contribution of the scintillator to the line-width broadening was studied, and it was demonstrated that it is the result of the nonlinear response of NaI(Tl) to electrons. A calculation of the intrinsic broadening due to this effect was made, and combined with a semiempirical function describing the broadening due to photomultiplier effects to give a calculated value of the over-all line width. At 661 kev the width was calculated to be 5.5% for a 2.5-in.-diameter by 2-in.-high crystal, which is to be compared with experimental values in the range 6 to 8%. It is pointed out that no account was taken of broadening due to imperfect crystal or optical effects and that the broadening must depend upon source configuration and crystal dimensions, the effects of which were not investigated. (auth)

6505 (ORNL-3016(p.313)) DENSITY OF IONS OUTSIDE A MAGNETICALLY CONFINED ARC. R. G. Alsmiller, Jr. (Oak Ridge National Lab., Tenn.).

The nonlinear equations governing the diffusion of ions out of a magnetically confined vacuum arc were studied. It was not possible to obtain results for cases of more than one ion species, which would be required for comparison with existing experimental data. (auth)

6506 (ORNL-3025) RAINBOW SCATTERING ANALYSIS OF RECENT HEAVY ION DATA. M. V. Goldman (Oak Ridge National Lab., Tenn.). Jan. 12, 1961. 30p. Contract W-7405-eng-26. OTS.

Heavy-ion elastic scattering cross sections recently obtained for C^{12}, N^{14}, O^{16}, and Ne^{20} by Au^{197} and Bi^{209}, and scattering of C^{12} by Ni^{59}, Ag^{107}, In^{113}, and Ta^{181}, all at about 10 Mev/nucleon incident energy, are fitted by means of the semiclassical rainbow model of Ford and Wheeler. Values of r_0 in very good agreement with the sharp cut-off model are found. The nonabsorbing nuclear surface thickness of the rainbow model is found to be about 2 fermis, or 18% of the interaction radius, and shows little variation with either projectile or target mass for these data. Several aspects of the theory itself are examined. (auth)

6507 (RADC-TN-60-118) FUEL CELL SYSTEMS. John E. McCormick (Rome Air Development Center, Griffis AFB, N. Y.). Apr. 20, 1960. 20p. Project No. 5561. (AD-241034).

The thermodynamics of fuel cells is discussed. Six different types of cells that have been proven feasible are described and the advantages and limitations of these six types are listed. (auth)

6508 (TID-6918) SCATTERING STUDIES WITH THE OHIO STATE UNIVERSITY CYCLOTRON. Annual Report for the Period October 1, 1959–September 30, 1960. Report No. 4. H. J. Hausman (Ohio State Univ. Research Foundation, Columbus). Sept. 30, 1960. 57p. RF Project 735. Contract AT(11-1)-503. OTS.

The design and development of components which have been, or are to be, included into the scattering system, including apparatus for short half-life measurements and silicon solid-state detectors, are discussed. Experiments described include $Si^{28}(p,p\gamma)$ 1.78-Mev angular correlations and distributions, use of solid-state detectors as dE/dx counters, and $Ca^{40}(p,p2\gamma)$ at 3.35 Mev. (W.D.M.)

6509 (TID-7591(p.40-8)) ANALYTICAL GAMMA SPECTROMETRY: SEMIEMPIRICAL ESTIMATIONS OF RESPONSE-CURVE SLOPES. Robert C. McIlhenny and Jane McCarthy (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.).

Applications of γ spectroscopy for quantitative analysis by measurement of the intensity of some selected feature are discussed. The intensity is expressed as count rate and is related experimentally to disintegration rate by measuring a series of samples with known activities placed in a standard position with respect to the crystal. A plot of these data gives the analytical response curve. The slope of this curve will depend on the nuclide and spectral features measured and in effect is the practical counting efficiency for that nuclide. Equations are presented and discussed which were devised to extend the general procedure for slope prediction to cylindrical sources. The primary modifications are in the method of calculating intrinsic efficiencies and the incorporation of a self-absorption correction. (C.H.)

6510 (TID-11004) DIFFUSION IN A TEMPERATURE GRADIENT. James S. Koehler (Illinois Univ., Urbana). 1960. 7p. OTS.

Methods of irreversible thermodynamics are used to obtain the vacancy concentration in a steady state along a temperature gradient. (W.L.H.)

6511 (TID-11050) LIQUID HYDROGEN BUBBLE CHAMBERS. ([Brookhaven National Lab., Upton, N. Y.]). [1960?]. 8p. [BNL-3700]. OTS.

For a detailed quantitative investigation of strange particle phenomena, liquid hydrogen bubble chambers are desirable since kinematics of interactions are simple and in principle, at least, allow a complete and unambiguous analysis of each event. Designs based on liquid and vapor expansion systems are described. (W.D.M.)

6512 (TID-11296) TECHNICAL PROGRESS REPORT [ON THEORETICAL PHYSICS]. R. H. Dalitz ([Chicago. Univ.]). [1960]. 11p. Contract AT(11-1)-264. OTS.

The status of various research projects in theoretical nuclear physics is reviewed briefly. (W.D.M.)

6513 (TID-11299) LOW ENERGY SPECTRUM OF ELECTRONS SCATTERED ON BOUND ELECTRONS. T. A. Weber, R. T. Deck, and C. J. Mullin (University of Notre Dame, Notre Dame, Ind.). [1959?] 20p. OTS.

The spectrum of electrons at low energies and large scattering angles resulting from the scattering of high-energy electrons on bound atomic electrons is calculated to lowest order in αZ and highest order in the incident energy. Relativistic Coulomb field effects are included by the use of wave functions correct to two orders in αZ. Inclusion of these relativistic Coulomb effects leads to a cross section significantly different from that obtained previously by the use of the plane wave approximation. The results show that the low energy spectrum of electrons scattered on bound atomic electons completely dominates the peak predicted by Parzen and coworkers in the low energy spectrum of bremsstrahlung producing electrons. (auth)

6514 (TID-11304) PRESSURE EFFECT ON VACANCY MIGRATION RATE IN GOLD. Roy M. Emrick (Illinois. Univ., Urbana). [1960]. 59p. OTS.

The effect of hydrostatic pressures up to 10,000 kg/cm^2 on the annealing rate of vacancies quenched in gold is studied. High-purity gold wires are quenched from 700°C, trapping in the equilibrium concentration of vacancies at

that temperature. The vacancies are then observed to anneal out in the vicinity of room temperature at various pressures by observing the decay of the quench induced residual resistance increase. A simple relation for the temperature dependence of the annealing rate is derived. Calculations of the lattice distortion around a vacancy and indirect experimental measurements of the volume change of the lattice on forming a vacancy indicate that there is considerable relaxation of the neighboring atoms about a vacancy. These results are used to explain the small value of the motional volume (1.50 ± 0.14 cm^3/mole). Activation volumes derived from measurements of the effect of pressure on the rate of self-diffusion are consistent with the present experimental value. (auth)

6515 (TID-11334) BASIC RADIATION STUDIES. Quarterly Progress Report No. 4 [for Period] August 1960–October 1960. (Johnston (William H.) Labs., Inc., Baltimore). 46p. Contract AT(11-1)-65 No. 8. OTS.

In the experimental program mass spectral data were obtained for argon, 1-3 butadiene, and nitrous oxide. The rate of progress of this phase of the program was accelerated by the completion of a fast, four-channel time analyzer circuit. Considerable emphasis was placed on the measurement of multiple ionization in mass spectra. Satisfactory measurements were made of the pulse height distributions for several prominent mass peaks in the argon and butadiene spectra. In relation to the multiple ionization work, a theoretical calculation of the moments of the pulse height distribution from an electron multiplier was completed. An interpretation of the measured pulse height distributions based on this calculation leads to some interesting and unexpected conclusions regarding pulse height distributions from electron multipliers when used to detect single particles. The bounded oscillator model in unimolecular reactions was extended to consider the effects of anharmonicity. A general conclusion resulting from this calculation is that the effects of boundedness and anharmonicity tend to cancel in the oscillator theory of unimolecular reactions. The radiation systems of nitrogen fixation and of ethylene glycol formation were analyzed. New and interesting information and conclusions are presented concerning these radiation processes. (For preceding period see TID-6951.) (auth)

6516 (TID-11344) THEORY OF NORMAL FERMION SYSTEMS. [Lecture presented at] International Spring School of Physics, April 20–May 7, 1960, Naples. A. Klein (Pennsylvania. Univ., Philadelphia). [1960]. 91p. OTS.

A series of lectures is presented in an attempt to develop a systematic account of normal fermion systems at or near absolute zero. A normal fermion system is one whose properties can be studied by means of a power series development in the potential assumed to act between the particles. (W.D.M.)

6517 (AEC-tr-4363) MASS-SPECTROMETRIC DETECTION OF THE MOLECULION $(NeA)^+$. R. Fuchs and W. Kaul. Translated from Z. Naturforsch. 15a, 108-15(1960). 21p. JCL.

In mass spectrometric examinations of Ne–Ar mixtures the heteronuclear inert-gas moleculion $(NeAr)^+$ was detected, which occurs more rarely by at least one order of magnitude than does the simultaneously observed homonuclear moleculion Ar_2^+. The $(NeAr)^+$ formation takes place through a two-stage process: (a) $Ne + e^- + E_{kin} \rightarrow Ne' + e^-$; (b) $Ne' + Ar \rightarrow (NeAr)^+ + e^-$. The excitation state Ne' is at 16.6 ev. The measurements confirm the formation process of Ar_2^+ at low pressures found by Hornbeck and Molnar. To this process there corresponds a value $\sigma \cdot \tau$, which as compared to that given by Hornbeck is greater by a factor 20. A search for the corresponding $(ArKr)^+$ moleculions yielded a positive result. In regard to their formation process no statement can be made at present. (auth)

6518 (AECL-1032) THE ABSOLUTE STANDARDIZATION OF RADIOACTIVE ISOTOPES WHICH DECAY BY ELECTRON CAPTURE. D. H. Vincent. Translated by J. Wilkinson from Nukleonik 1, 332-6(1959). AECL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 6969.

6519 (CEA-tr-A-786) CONTRIBUTION AUX MÉTHODES DE MESURE DU POTENTIEL ÉLECTRIQUE ATMOSPHÉRIQUE. (Methods of Measurement of the Atmospheric Electric Potential. Effects of Wind on Radioactive Condensers). R. Mühleisen. Translated into French from Z. Naturforsch. 6a, 667-71(1951). 18p.

The ionization due to a radioactive condenser makes the conductivity of the surrounding air vary in the direction of the wind. This results in a variation of the potential on the condenser. In order to measure this effect two similar devices were placed a little apart from each other. These devices have probes activated by polonium, a vacuum-tube voltmeter with a high input impedance, and a recording galvanometer. By comparing these double recordings with experiments in an artificial field a conclusion can be drawn that wind blowing at a low rate in the direction of the potential gradient can cause variations of the potential up to 30%. (tr-auth)

6520 (ERD-TN-60-772) ON THE SCATTERING OF HYDROMAGNETIC WAVES BY TURBULENT FLUCTUATIONS. A. G. Sitenko and Yu. (Iu.) A. Kirochkin. Translation of p.143-6 of "Voprosy Magnitnoi Gidrodinamiki i Dinamiki Plazmy," (a publication of the Publishing House of the Academy of Science of the Latvian SSR, Riga, 1959). 8p. (AD-241739).

The presence of inhomogeneities in a fluid due to the density or velocity fluctuations or of inhomogeneities in the magnetic field intensity leads to hydromagnetic wave scattering. In particular, hydromagnetic wave scattering by turbulent fluctuations in the velocity and magnetic field is possible in an incompressible fluid. The intensity of hydromagnetic wave scattering by turbulent fluctuations in the velocity and magnetic field intensity is determined. (W.L.H.)

6521 (IGRL-T/R-106) A METHOD USING INTEGRAL EQUATIONS IN THE THEORY OF DIFFRACTION. V. D. Kupradze. Translated by D. H. Hill from Mat. Sbornik 41, 561-74(1934). 22p.

The use of integral equations in problems related to the diffraction of electromagnetic waves extending in an infinite region containing obstacles of a fairly general form is discussed. Included are an analysis of setting the problems of integral equations and an investigation into the existence and uniqueness of solutions. (J.R.D.)

6522 (JPLAI/TR-17) THE EXCITATION OF ELECTRON OSCILLATIONS IN A SHOCK WAVE; APPLICATIONS TO RADIOASTRONOMY. Jean François Denisse and Yves Rocard. Translated from J. phys. radium 12, 893-9(1951). 27p.

Some characteristic properties of a shock wave which passes through a strongly ionized medium are

studied. Effects of both ordinary and thermal diffusion propel the electrons (the light particles) toward the front of the wave. The result is the polarization of the medium which finally limits the effects of diffusion. A distribution of the electron velocities differs considerably from a Maxwellian distribution. If the shock wave is sufficiently intense, the electrons may even be divided into two distinct groups of different average velocity. These properties normally lead to the stimulation of amplified plasma oscillations, and it is suggested that this mechanism could explain the most intense radioelectric solar emissions. (auth)

6523 (SCL-T-353) THE APPLICABILITY OF THE FORMULA OF SAHA TO THE ELECTRIC ARC. (De Toepasselijkheid van de Formule van Saha in de Electrische Lichtboog). A. M. Kruithof and J. A. Smit. Translated by Erik Arnhem (Sandia Corp.) from Physica 4, 129-43(1944). 19p. JCL.

The experimental verification of the formula of Saha for the central part of direct- and alternating-current arcs is presented. In a number of direct-current arcs it was found that the degree of ionization of the elements strontium and barium in the central part of the column can be well described by the formula of Saha. Systematic deviations, when present, were probably not greater than about 20%. Also with the investigated alternating-current arcs the Saha formula was found to be employable. Also here the results do not disclose a systematic difference with those in analogous direct-current arcs. (W.L.H.)

6524 (UCRL-Trans-451) THE THEORETICAL BASES FOR THE PREPARATION OF HIGH QUALITY, FINE-GRAIN PHOTOGRAPHIC EMULSIONS (THE PRINCIPLE OF HOMOGENEITY). K. S. Bogomolov. Translated from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst. No. 11, 6-16(1957). 23p. (Includes original, 11p.). JCL or LC.

The importance of homogeneity in nuclear emulsions is discussed, and methods for improving the homogeneity in fine-grain photomaterials are given. (T.R.H.)

6525 (UCRL-Trans-459) THE SCIENTIFIC PRINCIPLES OF A RATIONAL FORMULA FOR NUCLEAR PHOTOEMULSIONS THAT RECORD TRACES OF PARTICLES WITH MINIMUM IONIZATION (TYPE R). K. S. Bogomolov, A. A. Sirotinskaya, M. Yu. Deberdeev, and V. M. Uvarova. Translated by Richard B. Mudge from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst. No. 11, 73-86(1957). (Includes original, 14p.). 45p. JCL or LC.

The general principles that led to the development of the type R photoemulsion are discussed. These principles include shape and size of microcrystals and selection of basic method of synthesizing the emulsion, first ripening, separating the solid phase, dispersion, sensitization, second ripening, glazing and drying the photolayers, processing methods, and properties of type R photomaterials. (T.R.H.)

6526 (UCRL-Trans-460) TYPE MP AND MK PHOTOMATERIALS FOR MICROAUTORADIOGRAPHY. K. S. Bogomolov, M. Yu. Deberdeev, A. A. Sirotinskaya, and V. M. Uvarova. Translated by Esther S. Goldberg from Trudy Vsesoyuz. Nauch. Issledovatel.' Kinofotoinst. No. 11, 87-93(1957). 11p. JCL or LC.

NIKFI MK and MP plates for contrast microradioautography and its uses are described. The characteristics of these emulsions are given along with specifications for use, exposure conditions, processing methods, and formulas. Flexible-backed MK and MP plates are also available. Details are given of techniques for applying these plates to geological sections, metals, and histological slices. A removable layer film further increases the usefulness of these photomaterials. (T.R.H.)

6527 (UCRL-Trans-461) THE USE OF RADIOACTIVE ISOTOPES TO DETERMINE THE SENSITIVITY OF PHOTOPLATES USED TO RECORD CHARGED PARTICLES WITH MINIMUM IONIZATION CAPABILITY. (Primenenie Radioaktiyanykh Izotopov dlya Opredeleniya Chuvstvitel'nosti fotoplastinok Registriruyeshchikh Zaryazhennye Chastitsy s Minimal'noĭ Ioniziruyushcheĭ Sposobnost'ya). K. V. Starinin. Translated by Esther S. Goldberg from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst. No. 11, 94-101(1957). 20p. (Includes original, 8p.). JCL or LC.

The use of electrons from a β source to determine the sensitivities of emulsions designed for minimum ionization charged particles is considered in detail. (W.D.M.)

6528 (UCRL-Trans-462) SENSITIVITY DETERMINATION OF NUCLEAR PHOTOGRAPHIC EMULSION TYPE P ON A BETATRON WITH AN EXPOSED ELECTRON BEAM. K. V. Starinin and E. A. Gruz. Translated by Esther S. Goldberg from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst. No. 11, 102-5(1957). 7p. JCL or LC.

The sensitivity of films for nuclear experiments is determined by the density of charged particle tracks. An experiment to determine the sensitivity of P type emulsion is described in which it was necessary to employ single-charged particles of energy no lower than that corresponding to minimum ionization loss. (W.D.M.)

6529 (UCRL-Trans-565) THERMAL CONDUCTION OF PARAMAGNETIC DIELECTRICS AT LOW TEMPERATURES. I. Pomeranchuk. Translated from Zhur. Eksptl.' i Teoret. Fiz. 11, 226-45(1941). 38p. JCL or LC.

In paramagnetic dielectrics there is a paramagnetic energy spectrum. This spectrum participates in thermal conduction and it leads to an additional scattering of elastic waves. In a certain temperature region, the main role in thermal conduction is played by the paramagnetic spectrum. At low temperatures, thermal conduction of paramagnetic dielectrics is essentially of a nonmonotonic nature and sharply differs from thermal conduction of ordinary dielectrics. (W.L.H.)

6530 WAVE-OPTICAL TREATMENT OF THE RADIATION OF A MAGNETIC DIPOLE IN A PLANE-LAYERED MEDIUM ACCORDING TO THE EPSTEIN METHOD. Gottfried Eckart. Abhandl. bayer. Akad. Wiss. Math.-Naturw. Kl. No. 102, 1-85(1960). (In German)

Waves which are not appreciably affected by the ionosphere are treated as to the effects of atmospheric inhomogeneities. Reflection at plane layers is studied, and a wave-optical treatment according to the Epstein method is given. (T.R.H.)

6531 DIRECT MEASUREMENTS OF $(\partial p/\partial T)_v$ OF LIQUID HELIUM NEAR THE λ-CURVE. O. V. Lounasmaa and Leila Kaunisto (Univ. of Turku, Finland). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 59, 1-16(1960). (In English)

The $(\partial p/\partial T)_v$ of liquid helium-4 was measured near the λ curve at four different densities and found to be negative in both the helium I and II regions and to become positive 0.04 to 0.07°K above the transition temperature. The results are in agreement with the entropy diagram of Lounasmaa and Kojo and their implications are discussed. Equations are derived for the pressure and density of liquid helium-4 in terms of temperature along the λ curve. (D.L.C.)

6532 INTRODUCTION TO THE DYNAMIC STUDY OF DIFFUSION PROCESSES. André Régnier. Ann. Inst. Henri Poincaré 16, 47-110(1959). (In French)

A study is made, from the inertia point of view, of the statistical movements of a particle of matter. The chapter titles are: Generalities on Strongly Continuous Statistical Functions, General Diffusion Processes and Their Differential Properties, Kinetic Values Attached to a Diffusion Process, Dynamic Values Attached to Certain Diffusion Processes, the Dynamically Stationary Processes of Markov, and the Schrödinger Equation as Related to a Diffusion Process. (T.R.H.)

6533 SUMMARIZED PROCEEDINGS OF A CONFERENCE ON APPLIED SPECTROSCOPY–SEASCALE, JUNE 1960. L. Bovey and F. T. Birks (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Appl. Phys. 11, 525-34(1960) Dec.

The Summer Conference of the Applied Spectroscopy Group of The Institute of Physics was held at the Windscale Club, Seascale, near the United Kingdom Atomic Energy Authority Works, on June 16 and 17, 1960. About fifty members of the group assembled at this conference; and the papers presented, together with the ensuing discussion, are summarized. Among the topics discussed were the Mössbauer effect, the chemical and isotopic analyses of radioactive materials by spectroscopic and radioactivation techniques, the use of spectroscopy in the determination of discharge temperatures, and the development of monitoring systems for beryllium determination. (auth)

6534 IMAGE FORMATION BY ELECTRON BOMBARDMENT OF METAL TARGETS. E. H. Hirsch (Weapons Research Establishment, Salisbury, S. Australia). Brit. J. Appl. Phys. 11, 547-50(1960) Dec.

In a demountable vacuum system a latent image is formed of a region on a metal target that has been subjected to very weak electron bombardment. This image can be made visible by electroplating the target in a copper sulfate solution. An experimental investigation of the influence of bombarding current, electron energy, and target temperature is presented. The results suggest that the effect is due to the formation of a monolayer of hydrocarbon contamination, the build-up of which is catalytically accelerated by the metal target. The effect takes place even with 5 v electrons and can be used to obtain permanent visual records of slow electron beam focal spots. (auth)

6535 THE S-MATRIX IN THE NON-LOCAL FIELD THEORY OF ARNOUS AND HEITLER. L. O'Raifeartaigh (Universität, Zurich). Helv. Phys. Acta 33, 783-802(1960). (In English)

The general nonlocal field theory of Arnous and Heitler is considered for a specially chosen c-number form factor. A technique for evaluating the S-matrix is developed and with its help it is proven that the theory is convergent throughout in all orders of perturbation. However, with this form factor strict Lorentz invariance is not maintained but is confined to the first order of perturbation, as some explicit calculations (e.g. the self mass of the electron) show. (auth)

6536 A NOTE ON MULTIPOLE RADIATION. H. B. G. Casimir. Helv. Phys. Acta 33, 849-54(1960). (In English)

It has been shown that the expansion of a radiation field in a series of electric and magnetic multipole fields can be conveniently obtained by so-called Debye potentials, in the absence of group theory and vector harmonics. While this makes the treatment in a way more "elementary," the true nature of multipole fields is best expressed by their transformation properties in the same way as spherical harmonics of degree l are characterized by the property that under a rotation they transform according to a $(2l + 1)$-dimensional irreducible representation. A group-theoretical method is illustrated which leads in a logical straightforward way to the use of Debye potentials. (B.O.G.)

6537 THE DETERMINATION OF AVERAGE PRESSURES IN THE ZONE OF ELECTRICAL PULSE DISCHARGE. I. G. Nekrashevich and I. A. Bakuto (Inst. of Physics and Tech., Academy of Sciences, Minsk). Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R. 3, No. 7, 60-6(1960) July. (In Russian)

It is shown that a ballistic method can serve for the evaluation of average pressures in an electric discharge. For this, it is necessary to measure mechanical pulse, area of erosion traces, diameter and angle of grinding of electrodes. It is proposed that the value of the mechanical pulse be measured by means of a ballistic torsional pendulum and the average pressure calculated according to the approximation formulas. (auth)

6538 AN INVESTIGATION OF SPACE-TIME CHARACTERISTICS OF THE LUMINOUS CLOUD OF A SPARK DISCHARGE. E. G. Martinkov (Lenin State Univ., Minsk). Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R. 3, No. 7, 67-71(1960) July. (In Russian)

An arrangement is illustrated for the space-time analysis of the luminescence of separate spectral lines. With the aid of this arrangement, space-time analyses are made of spectral lines with various energy values in the upper layer. The photographs shown confirm the zonal character of the excitation of spectral lines. Near the surface of the flat electrode and also near the composite electrode, several current-conducting channels are observed to exist simultaneously. (auth)

6539 THEORY OF COUPLED FOLDED ANTENNAS. C. W. Harrison, Jr. (Sandia Corp., Albuquerque, N. Mex.) and Ronold King. IRE Trans. on Antennas and Propagation 8, 131-5(1960) Mar. (SCR-147)

Formulas for the mutual and self-impedance of two identical nonstaggered parallel-folded dipoles are developed. A generalization of the theory permits determination of these impedances for any identical dual configuration of wires, no matter how complicated, provided the structures are symmetrical with respect to the driving points. If the impedance of any single-conductor solid-wire element in a symmetrical circular array of linear radiators is known, the impedance of each element in a similar array consisting of folded-wire structures is readily obtained. Two obvious practical uses of the theory are the determination of the performance of a two-element folded antenna array, when one antenna is a tuned parasite, functioning as a director or reflector; and determination of the driving-point impedance of a folded antenna parallel to a highly conducting plane. (auth)

6540 EMISSION OF CHARGED FILAMENT MOVING PARALLEL TO THE INTERFACE OF TWO MEDIA. O. S. Margelyan (Inst. of Mathametics and Mechanics, Academy of Science, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz. Mat. Nauk 13, No. 3, 107-16(1960). (In Russian)

The emission from a filament moving parallel to the interface between media was previously studied and the

problem of Cherenkov effect on the motion was resolved by the method of images. A simple but quite accurate method is used for determining the Cherenkov effect induced by a current-carrying charged filament moving parallel to the interface of two media with various dielectric and magnetic constants. Expressions are derived for electric and magnetic fields and for the energy flux in both media. The character of various emissions was analyzed, and the effects of interference on the emission frequency distribution in the first medium were studied. (R.V.J.)

6541 NEUTRONS FROM SMALL TUBES. I. PHILLIPS TUBE: CONTINUOUS OR PULSED OPERATION. Otto Reifenschweiler (Phillips Research Labs., Eindhoven, Netherlands). Nucleonics 18, No. 12, 69-71(1960) Dec.

A sealed neutron-generator tube which uses the d-t reaction to produce 3×10^{10} neutrons/sec during continuous operation was developed. When adapted for pulsed operation, it yielded a peak output of 3×10^{10} neutrons/sec. This tube contains a Penning ion source, a 100 to 200 kv accelerating system, a replenisher to keep the pressure within the tube constant, and a titanium-tritium target that is self-replenishing. The Penning source supplies mainly molecular ions, but has as advantages long life, robustness, and simplicity. One tube was life-tested for 200 hr at an output of 2×10^{9} neutrons/sec with no fall-off in performance. This tube was also operated at ambient temperatures up to 120°C without any drop in yield. (M.C.G.)

6542 NEUTRONS FROM SMALL TUBES. II. SCHLUMBERGER TUBE: FOR OIL-WELL LOGGING. Arthur H. Frentrop and Harold Sherman (Schlumberger Well Surveying Corp., Ridgefield, Conn.). Nucleonics 18, No. 12, 72-4(1960) Dec.

A compact neutron generator tube that is intermediate in yield and size between radioactive sources and previous laboratory neutron sources was developed. Design requirements of long life, low power, portability, and operational simplicity were demonstrated in construction and test of more than 500 tubes. Applied power of 25 to 30 watts produced more than 10^{8} neutrons/sec in either continuous or pulsed operation at temperatures as great as 145°C and for periods longer than 100 hr. The tube contains a cold-cathode ion source, a close-spaced accelerating electrode geometry, a metal hydride for gas pressure control, and an impacted target continuously replenished by a mixed-isotope ion beam. Life tests indicated that the average tube could be operated for more than 200 hr at a yield of 10^{8} neutrons/sec. (M.C.G.)

6543 NEUTRONS FROM SMALL TUBES. III. KAMAN TUBE: THREE DIFFERENT ION SOURCES. Barney J. Carr (Kaman Aircraft Corp., Colorado Springs, Colo.). Nucleonics 18, No. 12, 75-6(1960) Dec.

Four sealed tubes, single-source, multisource, plasma, and high-voltage accelerator tubes, were developed as neutron generators. The single-source tube produces 10^{7} neutrons/pulse and contains an occluded-gas ion source, a pulse transformer, a titanium–tritium target, and a small ion pump. To produce 10^{10} neutrons in a 1 μsec pulse, a multisource tube with sources in parallel was developed. The plasma tube developed requires no magnetic field and can be operated for 30 hr at 10^{7} neutrons/sec at 1000, 3 μsec pulse/sec. The high-voltage accelerator produces 10^{9} to 10^{10} neutrons/sec and contains replaceable targets. (M.C.G.)

6544 QUANTUM EFFECT ON THE RADIAL DISTRIBUTION FUNCTION OF LIQUIDS. F. P. Ricci (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 16, 532-8(1960) May. (CNC-42)

The quantum effects in radial distribution functions of liquids were analyzed by means of the corresponding states principle. Also the best mode for describing liquid helium is discussed. (auth)

6545 CYCLOTRON RESONANCE IN LEAD. J. E. Aubrey (Univ. of Cambridge, Eng.). Phil. Mag. (8) 5, 1001-12(1960) Oct.

Cyclotron resonance effects of the Azbel'–Kaner type were observed in lead specimens at 9 kMc/sec and 1.2°K, and effective mass values of the charge carriers were deduced from the magnetic field dependence of the surface resistance of the specimens. The anisotropy of the surface conductivity of the single crystal specimens in the low field limit was found to be consistent with the existing model of the Fermi surface in lead, and from the value of the surface conductivity of a polycrystalline specimen, a value of the total Fermi surface area was found which supports the view that the fourth Brillouin zone in lead is empty. (auth)

6546 EXISTENCE OF DETONATIONS FOR SMALL VALUES OF THE RATE PARAMETER. W. W. Wood (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids 4, 46-60(1961) Jan.

The simplified, one-dimensional, steady-state Navier-Stokes detonation problem formulated by Hirschfelder, Curtiss, et al. was examined with respect to the existence of solutions when the reaction rate is small compared to the molecular collision rate. The latter condition is necessary for the assumed unimolecular mechanism to be valid, but is also the condition where solutions by numerical integration of the differential equations were not obtained. It is shown that solutions indeed exist for arbitrarily small values of the reaction rate, and that these solutions approach the von Neumann model of a shock preceding a deflagration. An asymptotic approximation to the solution is given which should be adequate for such small reaction rates. In order to make the steady-state problem mathematically well defined, the usual difficulty of the very small reaction rate in the initial state was removed by imposing an ignition temperature. It is shown that if the reaction rate and Mach number are held fixed while the ignition temperature is raised slightly above the von Neumann spike temperature, the solution changes to a flame having the same hot boundary state, but with the detonation von Neumann spike state as its initial state. (auth)

6547 THEORY OF THE COMPRESSIBILITY OF SOLID He^4 AND He^3 AT 0°K. Newton Bernardes (Ames Lab., Ames, Iowa). Phys. Rev. 120, 1927-32(1960) Dec. 15. (IS-157)

A quantum mechanical variational method is used to calculate several properties of a close-packed lattice phase of solid He^4 and He^3 at 0°K. The method consists in expressing the expectation value of the interatomic potential energy, with respect to a Heitler-London trial wave function, as a series of powers of the mean square deviation of an atom from its lattice site. Owing to the small mass of a helium atom, this mean square deviation is relatively large and the series converges slowly. Three sets of numerical results are obtained by truncating the series after the first, second, and third term, respectively. A comparison of the results with experimental data shows that the final results, i.e., after minimizing (H) with respect to the variational parameter, converge

much faster than the expectation value series itself. The results include values for: cohesive energy, sound velocity, compressibility, Debye temperature, and Grüneisen constant. The calculations are repeated for a body-centered cubic lattice, and no indication of a crystallographic phase transition is found. (auth)

6548 ELECTRICAL STRUCTURE OF PbS FILMS. D. P. Snowden and A. M. Portis (Univ. of California, Berkeley). Phys. Rev. 120, 1983-95(1960) Dec. 15.

The electrical properties of chemically deposited lead sulfide films were investigated as a function of frequency from direct current into the microwave range. Conductivity and Hall mobility measurements were made on both the dark and the photoexcited carriers. The dark conductivity is independent of frequency below 100 Mc/sec. It increases by almost an order of magnitude over a decade in frequency and then becomes constant again at higher frequencies. This behavior is typical of a material with low-frequency conductivity that is limited by barriers. Surprisingly the photoconductivity behaves quite differently. The photoconductivity has a hump around 100 Mc/sec but otherwise is relatively independent of frequency. The Hall mobilities of the dark and photocarriers are equal at direct current in agreement with earlier studies. Microwave Hall measurements indicate that the dark carriers have about the same apparent mobility at 10 kMc/sec as at direct current. It is shown that the conventional barrier model with a photoinduced change in carrier concentration cannot account for the behavior of these films; nor can a model in which the barrier height is modified by illumination. The present studies suggest that there are connecting channels through the films and that the photoresponse of the films is determined by the behavior of these channels. A simple model was constructed and its parameters adjusted to fit the conductivity data and the direct current Hall mobility. As a check on the model, the measured microwave Hall mobility was compared with the predicted value. Good agreement was found for high-quality commercial films. The hump observed in the photoconductivity follows naturally from this model, being associated with a modulation of the barrier capacitance. Studies of the photoconductive decay yield the same time constant at direct current and microwave frequencies, supporting the picture that the same photocarriers are responsible for the direct current and microwave photoconductivity. (auth)

6549 ION-ATOM POTENTIAL ENERGY FUNCTIONS OBTAINED FROM kev SCATTERING DATA. G. H. Lane and E. Everhart (Univ. of Connecticut, Storrs). Phys. Rev. 120, 2064-9(1960) Dec. 15.

The potential energy functions between ions and atoms in collision are determined from experimental data. The ion-atom combinations studied include Ar^+ on Ar, Ne^+ on Ar, Ne^+ on Ne, He^+ on Ar, He^+ on Ne, and He^+ on He, using differential cross-section measurements by Fuls, Jones, et al., at 25, 50, and 100 kev. The data are analyzed using equations developed by Firsov. The potential energies are positive, are in the range of one to sixty thousand electron volts, and correspond to ion-atom separations of a small fraction of an angstrom. The resultant potential energy curves are compared with a function derived by Firsov from a statistical model and they are found to fit fairly well. The fit to an exponentially screened Coulomb potential energy curve is not quite as good, but both these theoretical curves fall within the accuracy of the experimental data. (auth)

6550 NEUTRON DIFFRACTION INVESTIGATION OF MAGNETIC ORDERING IN THE TRIFLUORIDES OF 4d-TRANSITION ELEMENTS. M. L. Wilkinson, E. O. Wollan, H. R. Child, and J. W. Cable (Oak Ridge National Lab., Tenn.). Phys. Rev. 121, 74-7(1961) Jan. 1.

MoF_3 becomes antiferromagnetic below 185°K with a spin-only magnetic moment corresponding to $S = 3/2$ and a magnetic structure which can be correlated with coupling rules applicable to the iron-group trifluorides. The results, together with the absence of observable magnetic neutron scattering from PdF_3 and RuF_3, suggest that Hund's rule does not apply to ions in the 4d-transition series. (auth)

6551 HEAT CAPACITY OF FERROMAGNETIC SUPERCONDUCTORS. Norman E. Phillips (Univ. of California, Berkeley) and B. T. Matthias. Phys. Rev. 121, 105-7(1961) Jan. 1.

Heat capacity measurements on two samples from each of the systems $La_{1-x}Gd_x$ and $Y_{1-x}Gd_xOs_2$ show features which are correlated with the reported existence of both ferromagnetic and superconducting transitions. For one sample the measurements cover a wide enough temperature range to show that the entropy associated with the ordering of the gadolinium spins is the xRln8 expected for complete order. The heat capacities of the other samples are consistent with complete ordering. Superconducting transitions were observed both above and below the maximum in the heat capacity associated with the spin ordering. The entropy differences between the normal and superconducting states show that superconductivity is not confined to small volume elements but probably extends throughout the sample. (auth)

6552 MAGNETIC FIELD DEPENDENCE OF ENERGY GAP IN SUPERCONDUCTORS. K. K. Gupta and V. S. Mathur (Univ. of Chicago). Phys. Rev. 121, 107-17(1961) Jan. 1.

The dependence of energy gap in superconductors on static magnetic fields was derived in a gage-invariant way from the theory of Bardeen, Cooper, and Schrieffer. It was shown that the gap width decreases with magnetic field approaching the critical value. Optimum conditions were discussed for the observation of such an effect. The decrease in gap width was calculated for two superconductors, aluminum and tin, and it was shown that for a film thickness of 10^{-4} to 10^{-5} cm, the effect can be large enough to be observable. (auth)

6553 ELECTROLUMINESCENCE OF ZINC SULFIDE SINGLE CRYSTALS. I. T. Steinberger, V. Bar, and E. Alexander (Hebrew Univ., Jerusalem). Phys. Rev. 121, 118-24 (1961) Jan. 1.

In a series of experiments designed to distinguish between ionization and recombination processes during electroluminescence, rectangular voltage pulses were applied to single crystals of zinc sulfide. During the "on" period, the emission gradually increased to a stationary level. Removal of the voltage resulted in a burst of emission, which decayed slowly. This behavior is explained by the assumption of three field-dependent processes, namely: (a) ionization of centers in barrier regions; (b) sweeping out of the liberated electrons from the vicinity of the centers; and (c) tunnelling of electrons into the barrier regions. It was found that for a considerable voltage range the product of the light-sum (measured during the "off" period) by the current was proportional to the stationary emission level during the "on" period. This proportionality strongly supports the model suggested. In many cases the current was found to be more strongly dependent on the voltage than the light

sum. This result favors an ionization mechanism which is independent of the current. The model suggests furthermore an alternative explanation for the Neumark-effect, i.e., the enhancement of the thermal glow by electric fields. The explanation does not involve an impact-ionization mechanism. (auth)

6554 ELECTRONIC STRUCTURE OF THE CENTERS IN ZnS. Joseph L. Birman (Univ. of Pennsylvania, Philadelphia and General Telephone and Electronics Research Labs., Bayside, N. Y.). Phys. Rev. 121, 144-51(1961) Jan. 1.

A model of the common sulfide luminescent centers is proposed. The mutual perturbation of crystal eigenstates and transition-metal (activator) d eigenstates is assumed to give rise to the excited and unexcited eigenstates of the center. For substitutional $Cu^+(d^{10})$ in zincblende, zeroth order crystal field theory predicts that two sets of occupied center ground-state levels (T_2 and E) originating from d^{10} will exist. Additional level splittings result from (a) the spin-orbit effect, and (b) axial crystal field splittings in wurtzite. Experiments on visible and infrared, excitation and emission, are used to make tentative assignments of magnitude of level splittings. (auth)

6555 INTERATOMIC REPULSIVE POTENTIALS AT VERY SMALL AND INTERMEDIATE SEPARATIONS. Adolf A. Abrahamson (New York Univ., New York), Robert D. Hatcher, and George H. Vineyard. Phys. Rev. 121, 159-71(1961) Jan. 1. (BNL-4911)

Using a minimal and a maximal principle, respectively, two approximate expressions for the interaction potential between atoms are given such that their mean, $\bar{U}(R)$, differs from the exact value, U_0, in the Thomas-Fermi-Dirac (TFD) approximation, by not more than 4% for the case of two-center system; and by not more than 14%, in the Thomas-Fermi (TF) approximation, for the case of a three-center system. The respective limits of applicability of these potentials are discussed, and some of their applications are pointed out. (auth)

6556 CONTRIBUTION OF THE FERMI CONTACT TERM TO THE MAGNETIC FIELD AT THE NUCLEUS IN FERROMAGNETS. A. J. Freeman (Ordnance Materials Research Office, Watertown, Mass. and Massachusetts Inst. of Tech., Cambridge) and R. E. Watson. Phys. Rev. Letters 5, 498-500(1960) Dec. 1.

To calculate the Fermi contact contribution (H_c) of the core s electron polarization to the effective magnetic field at the Fe^{57} nucleus in ferromagnetic iron, spin exchange polarized Hartree-Fock calculations were made for the free ions Mn^{2+}, Fe^{2+}, and Ni^{2+} and for iron in both $3d^64s^2$ and $3d^8$ configurations. None of the results yield a H_c anywhere near the −530 kgauss value (based on an estimate of +200 kgauss for the contribution of the outer electrons) needed to explain the −333 kgauss value reported for H_e. A possibility of explaining the H_e value is discussed. (D.L.C.)

6557 MUONIUM FORMATION IN SEMICONDUCTORS. G. Feher (Bell Telephone Labs., Murray Hill, N. J. and Columbia Univ., New York), R. Prepost, and A. M. Sachs. Phys. Rev. Letters 5, 515-17(1960) Dec. 1.

The depolarization of muons in doped silicon, germanium, and graphite was studied by measuring the asymmetry in the angular distribution of positrons from muon decay. The results are discussed in terms of muonium formation, and the effects of donor concentration on the formation are considered. (D.L.C.)

6558 STIMULATED INFRARED EMISSION FROM TRIVALENT URANIUM. P. P. Sorokin and M. J. Stevenson (IBM Corp., Yorktown, N. Y.). Phys. Rev. Letters 5, 557-9(1960) Dec. 15.

Stimulated infrared emission from uranium(III) in CaF_2 was studied using a single CaF_2 crystal with 0.05 mole % uranium and silver films on both ends. The crystal was cooled with liquid helium and excited by a pulsed xenon discharge, and the radiation was isolated at 2.5μ and detected. Oscilloscope traces of the detector response showed the ratio between the stimulated emission and the background light to be >1000 and relaxation oscillations to be present, the number of spikes increasing with the power of the xenon discharge. (D.L.C.)

6559 DISSOCIATION OF H_2^+ AND He^- BY ELECTRIC FIELDS. A. C. Riviere and D. R. Sweetman (United Kingdom Atomic Energy Authority, Aldermaston, Berks, Eng.). Phys. Rev. Letters 5, 560-2(1960) Dec. 15.

Experiments were performed on the dissociation of 2-Mev H_2^+, 1-Mev He^-, and 0.33-Mev H^- ions by electric fields using fields up to 5×10^5 v/cm. The number of H_2^+ ions dissociated increases almost linearly for fields above 0.7×10^5 v/cm, while H_2^+ ions resulting from H_3^+ ion dissociation were dissociated to a much greater extent than those from the ion source. He^- ions were ionized completely by a field of 4.5×10^5 v/cm, while no effect was noted for H^- ions up to 5.4×10^5 v/cm. The results are compared with theoretical expectations. (D.L.C.)

6560 VISCOSITY OF LIQUID $^3He-^4He$ MIXTURES IN THE HELIUM II REGION ABOVE 1°K. F. A. Staas, K. W. Taconis, and K. Fokkens (Kamerlingh Onnes Laboratorium, Leiden). Physica 26, 669-86(1960) Sept. (In English)

The viscosity of liquid He^3-He^4 mixtures was derived from isothermal flow through a capillary 75.6 μ in diameter. The apparatus consists of two identical glass vessels, connected to each other by the glass capillary. The positions of both levels were measured as a function of time. It appeared that the logarithm of the level difference always decreased linearly with time, which means that Poiseuille's law is obeyed. The analysis of the flow was given. The values of the viscosity extrapolated to zero concentration (pure He^4) are in agreement with the measurements with the rotating cylinder by Heikkila and Hollis Hallett. There is satisfactory agreement in the low concentration region with the theory given by Zharkov. (auth)

6561 ON THE USE OF FORMAL OPERATOR TECHNIQUES IN QUANTUM STATISTICAL MECHANICS. A. S. Reiner (Weizmann Inst. of Science, Rehovoth, Israel). Physica 26, 700-16(1960) Sept. (In English)

An alternative derivation of the linked cluster expansions for the partition function of a grand canonical ensemble is given. It is shown that the cluster coefficients in that expansion are related to connected Bloch diagrams. In a time-independent approach, the contributions of those diagrams may be expressed in terms of the generalized scattering matrix of Watson. This t matrix for a hard core interaction was applied in a calculation of the three cluster coefficients of a boson gas of inpenetrable spheres. The results accord with those obtained by the binary collision method. The relation and differences in the various approaches are discussed. (auth)

6562 SELF-DIFFUSION OF ^4He AND QUANTUM CORRECTIONS. S. C. Saxena (Atomic Energy Establishment, Trombay, India). Physica 26, 730-6(1960) Sept. (In English)

Recent low-temperature data (1.74 to 296°K) of Bendt on the interdiffusion of He^3 and He^4 were interpreted. Quantum mechanical expressions were suggested for calculating the self-diffusion of a gas from the isotopic interdiffusion coefficient, and for the Schmidt number in analogy with the classical expressions. It is found that the Schmidt number is no more constant at low temperatures but varies in accordance with the proposed quantum mechanical expression. The experimental low-temperature diffusion coefficients agree well with the quantum mechanically calculated values. (auth)

6563 THERMODYNAMIC PROPERTIES OF LIQUID $^3He-^4He$ MIXTURES DERIVED FROM SPECIFIC HEAT MEASUREMENTS BETWEEN 0.4°K and 2°K OVER THE COMPLETE CONCENTRATION RANGE. R. De Bruyn Ouboter, K. W. Taconis, C. Le Pair, and J. J. M. Beenakker (Kamerlingh Onnes Laboratorium, Leiden). Physica 26, 853-888(1960) Nov. (In English)

Heat capacities of He^3-He^4 mixtures over the complete concentration range were measured using a calorimeter that could be cooled down to 0.4°K by means of evaporation of He^3. Special attention was given to the additional contribution to the specific heat due to the heat of mixing which was observed when stratification took place below the phase separation temperature and to the discontinuity in the specific heat at the corresponding Λ temperature. The heat of mixing was derived from the specific heat measurements inside and outside the phase separation region. The excess entropy was calculated. For dilute mixtures of He^3 in liquid He^4 at temperatures below 1°K the energy spectrum of Pomeranchuk seemed to be satisfied. (auth)

6564 THEORETICAL ASPECTS OF CATHODE SPUTTERING IN THE ENERGY RANGE OF 5-25 kev. P. K. Rol, J. M. Fluit, and J. Kistemaker (F.O.M. Laboratorium voor Massaspectrografie, Amsterdam). Physica 26, 1009-1011(1960) Nov. (In English)

A rigid sphere model was used to study the sputtering of copper by ion bombardment. Measurements indicated that the first collision of the ion near the target surface was chiefly responsible for sputtering. The energy transferred in the first collision, the collision radius, and the sputtering ratio were calculated. (M.C.G.)

6565 CONVERGING SHOCK WAVES IN VARIABLE GAS DENSITY. F. L. Chernous'ko. Priklad. Mat. i Mekhan. 24, 885-96(1960) Sept.-Oct. (In Russian)

The problem of spherical and cylindrical shock waves converging to the center of symmetry in a homogeneous stationary gas was studied previously, and an automodel solution for gas flow as a function of time was derived. The analysis was extended to a gas of variable density. (tr-auth)

6566 PROBLEMS ON DYNAMICS OF MAGNETO-VORTEX CONFIGURATIONS. Yu. P. Ladikov. Priklad. Mat. i Mekhan. 24, 897-905(1960) Sept.-Oct. (In Russian)

Equations are derived for the flow of coaxial magneto-vortex annuli, and various cases of such flow are analyzed. Circular plasma vortices with flowing currents are considered as magneto-vortex spheres. The fluid outside the annulus is considered ideal, noncompressing, and nonconducting. The plane analogue of a coaxial annulus system is a rectangular magneto-vortex couple with counter-circulation and currents distributed symmetrically in relation to a certain axis. Quantitatively, flow in the coaxial and rectangular cases differs little. Flow is studied for both conducting and nonconducting walls. It was found that in the first case the sphere expands toward the wall, whereas in the second case it contracts. If the wall has an aperture, the annulus may slide through it. (tr-auth)

6567 FLOW OF VISCOUS ELECTRO-CONDUCTING FLUID UNDER ROTATING DISC IN MAGNETIC FIELD. V. V. Sychev. Priklad. Mat. i Mekhan. 24, 906-8(1960) Sept.-Oct. (In Russian)

The problem of viscous incompressible fluid flow induced by an infinite, plain disk uniformly rotating around the axis was resolved by T. Karman (Z. angew. Math und Mech., V. I., 244, 1922). A generalization is developed for the case of fluid flow with finite electric conductivity in a uniform magnetic field perpendicular to the plane of the disk. The conductivity of the disk is taken as zero. (R.V.J.)

6568 ON THE INJECTION OF CONDUCTING FLUID OR GAS INTO THE BOUNDARY LAYER IN THE PRESENCE OF MAGNETIC FIELD. A. B. Vatazhin. Priklad. Mat. i Mekhan. 24, 909-11(1960) Sept.-Oct. (In Russian)

A mathematical analysis is made of the injection of conducting fluid into the boundary layer formed by a flat plane with a magnetic field perpendicular to the layer. (R.V.J.)

6569 ATTENUATION OF SHOCK WAVES IN A MOVING MEDIUM WITH VARIABLE DENSITY AND TEMPERATURE. O. Yu. Polyanskiĭ. Priklad. Mat. i Mekhan. 24, 912-15(1960) Sept.-Oct. (In Russian)

Propagation of shock waves in a moving medium with variable density and temperature is analyzed. It is assumed that the shock wave is weak and the length of the wave is smaller than the characteristic dimensions in the problem. It is shown that the nonlinear effects can be determined using the L. D. Landau analysis (Priklad. Mat. i Mekhan. 9, No. 4, 1945). Asymptotic formulas are developed for the pressures at the wave front and their variations in the density of the medium. (R.V.J.)

6570 ON THE FLOW OF A PLANE HYPERSONIC STREAM INTO NON-DISTURBED MEDIUM. V. A. Smirnov (Inst. of Mechanics, Academy of Sciences, Moscow). Priklad. Mat. i Mekhan. 24, 916-19(1960) Sept.-Oct. (In Russian)

A precise solution was derived for hypersonic stream flow. It is shown that at any arbitrary ratio of M numbers in an undisturbed stream and at its boundary, a shock wave forms in the stream before passing the first compression. The solution was derived for an infinite sequence of discrete values. (R.V.J.)

6571 ON THE STABILITY OF A GRAVITATING CYLINDER IN THE PRESENCE OF A MAGNETIC FIELD. F. C. Auluck and N. K. Nayyar (Univ. of Delhi). Proc. Natl. Inst. Sci. India, Pt. A, 26, 469-77(1960) Sept. 26. (In English)

The stability of a gravitating cylinder of infinitely conducting fluid is studied in the presence of poloidal magnetic fields that have a sinusoidal variation of type cos $(m\pi r^2/2R_0^2)$, where m is an odd integer, and as sin $(n\pi r^2/2R_0^2)$, where n is even integer, so that the magnetic field vanishes at the boundary. It is shown that the field increases the stability of the cylinder; and, for large values of m and n, the stabilizing effect of this field is the same as that of the uniform longitudinal magnetic field studied by Chandrasekhar and Fermi. (auth)

6572 LOW-TEMPERATURE BEHAVIOUR OF A BOSE GAS WITH HARD-SPHERE INTERACTION. R. K. Pathria

and A. D. Singh (Univ. of Delhi). Proc. Natl. Inst. Sci. India. Pt. A, 26, 520-31(1960) Sept. 26. (In English)

Using the energy-momentum relation derived by Brueckner and Sawada, the low-temperature thermodynamical properties of a Bose gas with hard-sphere interaction are investigated. The two cases, (1) when this energy spectrum is similar to that observed in liquid helium II and (2) when it becomes similar to that derived by Lee, Huang, and Yang, are investigated separately. In the first case (where the spectrum exhibits a nonmonotonic character), the analytical derivation of the expressions for the various thermodynamical properties is rendered possible by dividing the momentum range into three suitable intervals such that within each interval the ϵ-p relation can be approximated to a simple algebraic one. The numerical magnitudes of the various parameters characterizing the algebraic relations are calculated for the case of a gas with density equal to that of liquid helium(II) and for three plausible values of the hard-sphere diameter. The calculated results agree qualitatively with those obtained from the experimental study of this liquid. For the second case, expressions are derived for the various macroscopic properties of the assembly in terms of suitable mathematical functions and then are written down in the form of series expansions for the two particular cases of interest. (auth)

6573 EFFICIENT PRODUCTION OF MULTIPLY CHARGED POSITIVE IONS BY LOW ENERGY STRIPPING IN HELIUM GAS. S. K. Allison, J. Cuevas, and M. Garcia-Munoz (Univ. of Chicago). Rev. Sci. Instr. 31, 1193-7 (1960) Nov.

"Low energy" as used here means ionic and atomic beam velocities of $\sim 5 \times 10^7$ to 2×10^8 cm/sec. In this velocity region an ion beam brought to charge equilibrium in helium gas has a much greater content of components of high positive charge than does the same beam charge equilibrated in other gases. To achieve this effect the pressure of helium gas in a charge stripper or converter cell placed in the beam path must be much higher than in other gases. The predicted effect, calculated from the charge changing cross sections, is verified by experiments on the stripping of Li^+ to Li^{2+} in air and helium. In a qualitative experiment the proton beam of the Chicago synchrocyclotron was increased 100% by equilibrating the hydrogen constituent in a 90 He−10 H_2 mixture before issuing it from the ion source into the acceleration chamber. (auth)

6574 KINEMATIC EFFECTS IN TARGET THICKNESS CALCULATIONS. Isam Naqib and David K. McDaniels (Univ. of Washington, Seattle). Rev. Sci. Instr. 31, 1358-60(1960) Dec.

A generalization is given of Cohen's results on calculations showing the effects of target energy loss on resolution, and a relation between the target angle and scattered particle angle which optimizes the energy spread of outgoing particles. (B.O.G.)

6575 EJECTION OF ELECTRONS FROM METALS BY IONS. N. N. Petrov (Leningrad Polytechnic Inst.). Soviet Phys.-Solid State 2, 1182-8(1960) Dec.

The excitation of bound electrons in metal was investigated to determine the nature of the kinetic ejection of electrons by ions. The temperature dependence of potential ejection of electrons, the dependence $\gamma = f(E)$, the effect of the energy expended in the formation of the bombarding ion, and the role of energy losses by the excited electrons are discussed. Experimental data showed the existence of a "threshold" of kinetic ejection. Above this threshold ion-electron emission increased linearly with increasing energy for argon and potassium ions. The electron ejection by potassium and argon ions was the same and did not depend on the material of the target for ion energies of 0.5 to 6 kev. It was assumed that in the cases studied, excitation of bound electrons in the metal took place. Electron ejection by He, H_2, Hg, Li, and Cs ions was also studied. (M.C.G.)

6576 THE SPEED OF THE MOTION OF THE IONIZATION FRONT FOR THE SPARK IN LONG DISCHARGE PIPES. A. V. Nedospasov and A. E. Novik. Zhur. Tekh. Fiz. 30, 1329-36(1960) Nov. (In Russian)

Phenomena appearing in long gas-discharges during an intensity increase from 10^5 to 10^6 v/sec are studied. The short-time discharge between the electrode and walls along the tube is followed by ionization and formation of primary plasma. The rate of the process is determined in relation to type of gas pressure, tube diameter, wall volume, and, rate of electrode potential change. (tr-auth)

6577 BULLETIN OF THE AMERICAN PHYSICAL SOCIETY, INCLUDING THE PROGRAMME OF THE 1960 WINTER MEETING IN THE WEST AT THE UNIVERSITY OF CALIFORNIA, BERKELEY, DECEMBER 29-31, 1960. New York, American Physical Society, Columbia University, 1960. p.487-520.

Abstracts and/or titles are given for 139 papers on the following subjects: ferromagnetism and spin resonance, astrophysics, low-energy and high-energy nuclear physics, electron physics, biophysics, microwave resonance, helium and phonon physics, molecular beams and gas ions, theoretical physics, solid state and semiconductors, shock waves, etc. Titles are also given for 21 papers presented at the Topical Conference on Strong Interactions on Dec. 27 to 29, 1960. (D.L.C.)

6578 PROPULSION BY COMPOSITE BEAMS OF NEGATIVE AND POSITIVE IONS. M. A. Gilleo and S. W. Kash (Lockheed Aircraft Corp., Sunnyvale, Calif.). Paper No. 1157-60. Presented at the Semi-Annual Meeting and Astronautical Exposition, Los Angeles, California, May 9-12, 1960. New York, American Rocket Society, 1960. 17p.

A composite ion accelerator which provides beams of negative and positive ions of equal number density is proposed for space propulsion. A number of composite ion accelerator arrangements can be devised. Such devices are possible because negative ions may be produced by surface ionization at suitable heated surfaces just as positive ions are produced in most of the ion propulsion devices presently under consideration. The use of negative ions instead of electrons offers several distinct advantages. In this case almost all heated surfaces are directly associated with the production of thrust. Thus, much of the energy previously wasted by radiation from the thermionic emitter surfaces which provide electrons for neutralization is associated productively with thrust. Furthermore, the use of both positive and negative ions may allow a more compact accelerator than one which employs only positive ions, and it may permit the employment of less chemically reactive materials for the propellant than is possible with positive ion-electron accelerators. (auth)

6579 USE OF PERIGEE PROPULSION FOR ORBITAL LAUNCH OF NUCLEAR ROCKETS. Paul G. Johnson and Frank E. Rom (Lewis Research Center, Cleveland). Preprint No. 60-75. Presented at the Western National Meeting, American Astronautical Society, August 8-11, 1960,

Seattle, Washington. New York, American Astronautical Society, 1960. 33p.

Nuclear-rocket propulsion with low-power reactors (producing orbital-launch accelerations of about 10^{-2} g) permits powerplant weight reduction and specific-impulse improvement but is extravagant in propellant expenditure with continuous thrust. "Perigee propulsion" is a thrust program to minimize the "gravity loss" associated with low-acceleration, continuous-thrust propulsion. Thrust is intermittent, being applied when vehicle velocity is highest, that is, near the perigees of the elliptic coasting paths between propulsion periods. The increased energy-addition efficiency yields mass ratios approaching those for impulsive velocity change. Although corresponding propulsion times are measured in days, they are still small relative to mission times measured in months. A trajectory analysis defines the possible compromises between mass ratio and propulsion time, and residual loads of perigee-propulsion and continuous-thrust systems are compared for specified missions. Perigee-propulsion systems can equal continuous-thrust performance with reactor powers less by factors of 6 to 20. Low powers offer easier powerplant development and opportunities to use different reactor materials. No significant penalties due to afterheat or control requirements are apparent. Radiation-belt exposure time is estimated to be 12 to 36 hours, intermediate between those of high-acceleration vehicles and electric-propulsion spacecraft. (auth)

6580 THERMOELECTRICITY ABSTRACTS. Compiled in the Library Branch, Technical Information Division. (Naval Research Lab., Washington, D. C.). Aug. 1960. 87p.

Available at OTS as PB-161301.

A bibliography (No. 4) of 536 references is presented with abstracts for most of them and arranged by author, issuing agency, or title. Items of interest from the thermoelectric standpoint are covered as well as items on specific thermoelectric research and applications. No index is included. (D.L.C.)

6581 IMPROVEMENTS IN METHOD AND APPARATUS FOR THE DIRECT CONVERSION OF THERMAL TO ELECTRICAL ENERGY. (to General Electric Co.). British Patent 854,036. Nov. 16, 1960.

A method of converting thermal energy to electric energy is outlined in which a pair of electrode surfaces with differing work functions is supported in a vacuum-tight enclosure and kept at different temperatures; the electrode with the higher work function is maintained at temperatures above 1400°K and the other at least 700°K below that of the first. Cesium vapor is introduced into the enclosure to coat the cool electrode completely and the hot electrode partially and to neutralize the space charge between the electrodes; in this way, the electrode voltage approaches the contact potential between the two electrode surfaces. In the preferred embodiment of this method, the hot electrode is molybdenum, the cool electrode is oxidized silver, and the support is a ceramic insulator. A plot of the logarithm of electron emission vs. 1/T for various cesium vapor temperatures illustrates the kind of performance that may be obtained. (D.L.C.)

Cosmic Radiation

6582 (AFCRC-TN-60-412) THE DAILY VARIATION OF THE COSMIC RAY NUCLEONIC COMPONENT AT MURCHISON BAY AND UPPSALA. Technical Note No. 2. Arne Eld Sandström, Eric Dyring, and Stig Lindgren (Uppsala Univ. Inst. of Physics). Feb. 8, 1960. 32p. Contract AF 61(514)-1312. (AD-243527).

The first and second harmonics of the mean daily variation were determined both for yearly periods and for each sun rotation period. Vector sum diagrams for the first harmonics in the latter case are given. In some instances a considerable phase shift has taken place from one sequence of sun rotation periods to another. These phase shifts were not contemporary at the two stations. The first harmonic of the 12-month means displays a high degree of constancy with only a small secular phase shift. The amplitudes of the second harmonics are very small. Conditions are especially favorable concerning the deviation in the earth's magnetic field of the particles registered by the Murchison Bay monitor. Accordingly it was possible to determine the direction of the anisotropy with a fairly good accuracy. The Murchison Bay records do not show any prominent phase shift with the K_p index. Concerning Uppsala, days with $[K_p]_{max} \leqq 1^+$ may have a much later time of maximum than other days. There appears to be a small but consistent variation of the amplitude with K_p index. (auth)

6583 SPECTRA OF π^- MESONS GENERATED BY THE CHARGED COMPONENT OF COSMIC RADIATION. G. V. Khrimyan, T. L. Asatiani, and V. M. Krishchyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz. Mat. Nauk 13, No. 3, 117-22(1960). (In Russian)

The spectra of π^- mesons generated in lead by the charged component of cosmic radiation were measured with a magnetic spectrometer at 3200 m elevation (Aragats mountain). The thickness of the lead was varied from 10 to 25 cm; 6 graphite absorbers of total thickness 21.7 g/cm^2 and a copper absorber of 100 g/cm^2 were used. In addition to stopped particles, all particles generated in nuclear reactions with not less than $n > 2$ prongs were recorded. The π^- mesons were identified by their nuclear interaction in the absorbers. Particles were considered to have interacted when nonionizing stoppage occurred in the absorber, when the scattering angle exceeded 3 times the angle of multiple scattering, and when not less than 3 prongs were formed with one prong passing one of the filters. The spectra for π^- mesons (169 particles) generated in stars ($n \geq 3$) are plotted, and the obtained γ value is in good agreement with published data. (R.V.J.)

6584 ON THE ACCURACY IN DETERMINING DISCRETE SOURCES OF COSMIC RADIATION. E. S. Burunsuzyan. Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz. Mat. Nauk 13, No. 3, 123-32(1960). (In Russian)

A further analysis was made of the problems arising in determining discrete sources of cosmic radiation, and expressions are derived for verifying the data in Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz. Mat. Nauk 13, No. 1, 1960. In order to derive more reliable data on discrete sources of cosmic radiation, it is necessary to reduce the dispersion of fluctuations not by averaging by time but by averaging the various samples. At equal thresholds of observation, multiple observations and averaged data produce more accurate results than an integrated single observation. (R.V.J.)

6585 EXTENSIVE AIR SHOWERS AND THE UPPER ATMOSPHERE. C. A. Pearson and S. T. Butler (Univ. of Sydney). Nuovo cimento (10) 18, 251-65(1960) Oct. 16. (In English)

McCusker explained the solar variations in counting rate

of extensive air showers in terms of a tidal change in the height of the first primary interaction. It is possible to obtain the very large amplitudes McCusker found with an amplitude of tidal motion in the ozone layer of 3 to 10 km provided the high-energy primaries involved are heavy. (auth)

6586 THE FRAGMENTATION PROBABILITIES OF FAST HEAVY COSMIC-RAY PRIMARIES IN TEFLON. F. A. Brisbout, C. F. Gauld, and C. B. A. McCusker (Univ. of Sydney). Nuovo cimento (10) 18, 400-2(1960) Oct. 16. (In English)

A study was made of the fragmentation of cosmic primaries in Ilford G-5 emulsions and in Teflon to determine the fragmentation probabilities in air. The results are tabulated, giving average numbers per interaction for various products and primaries. Comparing the present results with those of Lohrmann and Teucher, within the limits of statistical accuracy it is seen that there is good agreement in the emulsion-to-emulsion and for the Teflon-to-light target nuclei results. Thus, in using a material that is a close approximation in individual and average Z to the atmosphere, the experiment justifies the belief that "fragmentation probabilities" obtained from studies of collisions with $N_h < 7$ in emulsions are in close approximation to those occurring in the atmosphere. (B.O.G.)

6587 THE DETERMINATION OF THE FLUX OF COSMIC RAY PROTONS WITH NUCLEAR EMULSIONS. C. J. Waddington (Univ. of Bristol, Eng.). Phil. Mag. (8) 5, 1105-17(1960) Nov.

The flux of protons in the primary cosmic radiation was determined in a stack of nuclear emulsions exposed during 1954 over northern Italy. This determination, which depended on the observation of the nuclear interactions produced by the protons, gave a flux at the top of the atmosphere of 500 ± 70 protons/m^2 steradians sec, a value in good agreement with that expected from counter measurements. A simple model of the variation of the proton flux with depth in the atmosphere was derived which appears to be in reasonable agreement with the experimental data. (auth)

6588 THE VARIATION WITH TIME OF THE FLUX AND ENERGY SPECTRUM OF PRIMARY COSMIC RAY ALPHA PARTICLES. P. J. Duke (Univ. of Bristol, Eng.). Phil. Mag. (8) 5, 1151-9(1960) Nov.

The total flux and energy spectrum of primary cosmic alpha particles at the top of the atmosphere were measured in emulsion stacks flown during September 1956 and June 1958. Values of 240 ± 26 and 130 ± 15 particles/m^2 steradian second respectively were obtained for the total flux. This reduction in the flux during June 1958 was caused by the partial removal of those alpha particles with energies between 100 and 2000 Mev/nucleon. These changes were correlated with the 11-year cycle of solar activity. (auth)

6589 RESONANT SCATTERING OF ANTINEUTRINOS. J. C. Barton (Northern Polytechnic, London). Phys. Rev. Letters 5, 514(1960) Dec. 1.

A cosmic ray recorder operated for 21 days underground at a depth of 5050 mwe yielded no cosmic-ray events, which means that the meson flux is probably less than 0.5/m^2 day and there is probably no resonance in antineutrino scattering by electrons involving a virtual charged boson (muon) with a mass equal to that of a K meson. (D.L.C.)

6590 THE CORPUSCULAR RADIATION ENVIRONMENT OF THE EARTH. S. F. Singer (Univ. of Maryland, College Park). Paper No. 782-59. Presented at the ARS Controllable Satellites Conference, M.I.T., April 30–May 1, 1959. New York, American Rocket Society, 1959. 14p. (AFCRC-TN-59-296; AD-216312)

From the point of view of space flight, two types of phenomena are of importance in the vicinity of the earth: the trapped particles which make up the earth's radiation, and primary cosmic radiation. Problems which arise in connection with the earth's radiation belt are discussed. There are in reality two radiation belts which coexist in the earth's magnetic field as trapped particles: one is soft and of solar origin, the other is hard and of cosmic ray origin. The latitude and altitude distribution is different for the two types, and so is the nature of the radiation, and therefore the shielding problem. Shielding is very difficult for the hard radiation belt; large thicknesses of material are needed to reduce the radiation level to a tolerable value. It may therefore be more promising to reduce the radiation belt intensities by eliminating the particles themselves through operation of satellites which "sweep" the space around the earth by absorbing the particles which hit them. Against high energy primary cosmic rays (consisting of protons and heavier nuclei) shielding may be of no avail; however, the intensities involved should be small. Shields of hydrocarbons turn out to be most effective against heavy primaries by producing fragmentations which break up the incident heavy nucleus into smaller particles; the ionization density is thereby considerably reduced, and so is the biological effectiveness. But cosmic ray increases following solar flares can be fatal. (auth)

Criticality Studies

6591 (HW-64866(p.143-7)) CRITICAL APPROACH AND EXPONENTIAL MEASUREMENTS WITH 3.1 PER CENT ENRICHED URANIUM RODS IN LIGHT WATER. R. C. Lloyd, E. D. Clayton, and R. B. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A series of exponential and critical approach measurements were previously made with 3.063% enriched uranium rods in water. The data are summarized, and plots are given of maximum buckling and minimum critical mass in spherical geometry vs. rod diameter and the extrapolation length vs. H_2O/U volume ratio. (W.D.M.)

6592 (HW-64866(p.150-1)) EXPONENTIAL MEASUREMENTS OF NATURAL URANIUM–WATER SYSTEMS. R. C. Lloyd (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A series of exponential measurements was started with 0.925-in. diameter natural uranium fuel elements in water. The purpose was to obtain further data on the critical mass of natural uranium in light water and to obtain buckling values for the interpretation of planned experiments involving a 3% enriched uranium lattice reflected by a natural uranium tamper. (W.D.M.)

6593 (ORNL-3016(p.71)) HOMOGENEOUS CRITICAL ASSEMBLIES OF 2% U^{235}-ENRICHED UF_4 IN PARAFFIN. J. T. Mihalczo and J. J. Lynn (Oak Ridge National Lab., Tenn.).

Additional critical experiments were performed with a homogeneous mixture of 2% U^{235}-enriched UF_4 and paraffin, the $H:U^{235}$ atomic ratio for these later experiments being 501. The results were combined with those of earlier experiments, in which $H:U^{235}$ ratios of 195,

294, and 404 were used, to present plots of minimum critical masses and volumes. (auth)

6594 (ORNL-3016(p.72-3)) CRITICAL DIMENSIONS OF RANDOM ARRAYS OF ThO_2–UO_2 PELLETS. J. K. Fox and L. W. Gilley (Oak Ridge National Lab., Tenn.).

Several criticality experiments were performed with assemblies of unclad ThO_2 - UO_2 pellets, randomly stacked in aluminum or steel cylinders. Water was added to the cylinders to serve as neutron moderator, and all assemblies were completely water-reflected. The results of these measurements and of preliminary experiments in which the pellets were contained in plastic bottles indicated that the critical dimensions of assemblies of such pellets are extremely sensitive to the degree of neutron moderation. (auth)

6595 (ORNL-3016(p.73-6)) CRITICAL PARAMETERS OF BARE AND REFLECTED 93.4 wt. % U_{235}-ENRICHED URANIUM METAL SLABS. J. T. Mihalczo and J. J. Lynn (Oak Ridge National Lab., Tenn.).

The critical parameters of slabs of 93.4 wt. % U^{235}-enriched uranium metal were measured in a series of neutron multiplication experiments. The effect of Plexiglas as a neutron reflector was determined, and a limited number of measurements with graphite and beryllium reflectors were made. The data were extrapolated to give 2.4 in. as the thickness of an infinite, unreflected critical slab and 0.6 in. as the thickness of an infinite critical slab reflected by 6 in. of Plexiglas. (auth)

6596 (ORNL-3016(p.154-6)) COMPARISON THEOREMS FOR THE ESTIMATION OF CRITICALITY IN BARE, ONE-VELOCITY REACTORS. L. Dresner (Oak Ridge National Lab., Tenn.).

Several theorems are given for the estimation of the critical multiplication in a bare, one-velocity reactor with isotropic scattering. (auth)

6597 NEGATIVE-REACTIVITY MEASUREMENTS. William S. Hogan (Battelle Memorial Inst., Columbus, Ohio). Nuclear Sci. and Eng. 8, 518-22(1960) Dec.

Negative-reactivity measurements are frequently made by the rod-drop and source-jerk techniques. Analysis of the data from such experiments by the usual methods requires measurement of the flux-time curve during a transient. Two alternative methods of obtaining negative reactivities are presented. Neither of the methods require measurement of a flux transient. Experimental results using these methods are given. (auth)

6598 PERTURBATION THEORY OF REACTIVITY COEFFICIENTS FOR FAST-NEUTRON CRITICAL SYSTEMS. Gordon E. Hansen and Clifford Maier (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 532-42 (1960) Dec.

The first-order perturbation theory, or equivalently the interpretation of reactivity coefficients, is illustrated for fast neutron critical systems. A second-order perturbation theory for small size sample replacements is given and illustrated especially as it pertains to measurements of reactivity coefficients. (auth)

6599 REACTIVITY CONTRIBUTIONS OF VARIOUS MATERIALS IN TOPSY, GODIVA, AND JEZEBEL. L. B. Engle, G. E. Hansen, and H. C. Paxton (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 543-69(1960) Dec.

An accumulation of reactivity contribution data is brought together for the various critical assemblies at Pajarito. Corresponding values of effective absorption and transport cross sections are derived, and relations between critical mass and volume fraction of diluents are obtained in terms of these cross sections. In some favorable cases, inelastic scattering contributions to the effective absorption cross sections are estimated. (auth)

6600 CRITICAL PLUTONIUM AND ENRICHED-URANIUM-METAL CYLINDERS OF EXTREME SHAPE. G. E. Hansen, H. C. Paxton, and D. P. Wood (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 570-7 (1960) Dec.

Critical configurations were established with enriched uranium in the form of squat 15.0-in. dia. cylinders and elongated 3.24-in. dia. cylinders. These cores were reflected by depleted uranium, polyethylene, graphite, and water; the squat cylinder was unreflected and reflected by beryllium of various thicknesses. Critical systems of plutonium were squat 6.0-in. dia. cylinders and elongated 2.25-in. dia. cylinders reflected by normal uranium, graphite, water, and in one case, polyethylene. Observed critical heights and diameters were corrected to correspond to standard enriched-uranium and plutonium densities and concentrations. These are tabulated along with effective extrapolation distances. (auth)

6601 CRITICAL MASSES OF CYLINDERS OF PLUTONIUM DILUTED WITH OTHER METALS. D. P. Wood, C. C. Byers, and L. C. Osborn (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 578-87(1960) Dec.

Critical masses of 6-in. dia. cylinders of plutonium diluted in various volume ratios with steel, aluminum, thorium, air, and depleted uranium were determined. The cores were in 0, 2, 4.5, or 7.5-in. thick uranium reflectors and in 2, 4.5, or 7.5-in. thick thorium reflectors. From these data, the equivalent spherical critical masses of plutonium were estimated. An appendix gives reflector savings of undiluted plutonium for a variety of materials. (auth)

6602 CRITICAL MASSES OF ENRICHED-URANIUM CYLINDERS WITH MULTIPLE REFLECTORS OF MEDIUM-Z ELEMENTS. G. E. Hansen, D. P. Wood, and W. U. Geer (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 588-94(1960) Dec.

Critical masses were measured for enriched-uranium-metal cylinders reflected on both ends and on one end only by multiple layers of two and three of the metals copper, iron, zinc, nickel, and stainless steel. For other measurements the core was partially moderated with graphite and with polyethylene so as to give the influence of decreased neutron energy upon reflector savings of the multiple reflectors. Critical mass values with composite reflectors are less than the simple averages of values for the elements alone. This reduction of critical mass, most pronounced for the Ni-Fe reflectors, is primarily because the self-shielding of the scattering resonances in medium-Z elements is appreciable when one-element reflectors are used, and is reduced when two or more of these elements are mixed in the reflectors. (auth)

6603 LEAKAGE NEUTRON SPECTRUM FROM A BARE Pu^{239} CRITICAL ASSEMBLY. Leona Stewart (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 595-7(1960) Dec.

The leakage neutron spectrum of a bare Pu^{239} critical assembly was measured with nuclear emulsions as both

radiator and detector. A comparison with similar measurements on the U^{235} analog of this assembly indicates a higher average energy for the Pu^{239} neutrons. (auth)

6604 CRITICAL REFLECTOR THICKNESSES FOR SPHERICAL U^{233} AND Pu^{239} SYSTEMS. E. A. Plassmann and D. P. Wood (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 615-20(1960) Dec.

The thickness of reflectors required for critical configurations with spheres of U^{233} and Pu^{239} were estimated from multiplication measurements of nearly critical assemblies. Reflector materials employed were uranium enriched in U^{235}, normal uranium, beryllium, and tungsten alloy. Correction of the experimental data was attempted to give "idealized" dimensions, i.e., a solid core in intimate contact with its reflector material. (auth)

6605 A URANIUM–METAL EXPONENTIAL EXPERIMENT. Curtis G. Chezem (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 652-69(1960) Dec.

Certain conflicts arising from previous measurements of neutron flux parameters in the equilibrium spectrum of natural uranium were resolved. The parameters which were investigated are given along with "best" values as measured in this work: Material buckling, -0.0119 ± 0.0005 cm^{-2}; Diffusion length, 9.17 ± 0.18 cm; U^{235}/U^{238} fission cross-section ratio, 239 ± 7; Pu^{239}/U^{238} fission cross-section ratio, 250 ± 16; Np^{237}/U^{238} fission cross-section ratio, 14.5 ± 0.5; and U^{238} inelastic scattering cross section, 2.00 ± 0.04 barns. The experiment was performed at the Pajarito critical assemblies facility utilizing two exponential columns of natural uranium, each 30.7-in. high, having diameters of 15 and 21 in. and excited by a small fast reactor. The system was outdoors, elevated some 11 ft above the ground level to reduce flux perturbations due to backscattering of neutrons. Perturbation corrected measurements in both columns made by several detection methods and with various source spectra agree to within experimental error and are consistent with calculated values. (auth)

6606 ASSEMBLY OF FISSIONABLE MATERIAL IN THE PRESENCE OF A WEAK NEUTRON SOURCE. G. E. Hansen (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 709-19(1960) Dec.

The probability distribution in time at which the neutron population in a slightly supercritical system attains a prescribed level is considered for the case where a source injects well under one neutron per neutron lifetime. For the case of ramp insertion of reactivity it is shown that the energy released in the consequent burst of fissions may in some cases (e.g., unmoderated enriched uranium systems) exceed by over a factor of 100 the energy release predicted by the reactor kinetics equations. (auth)

Elementary Particles and Radiations

6607 (FZM-1980) THE EFFECT OF SAMPLE PARAMETERS ON ENERGY ABSORPTION FROM A NEUTRON BEAM. R. L. Johnston (Convair, Fort Worth, Tex.). June 26, 1960. 37p.

A Monte Carlo computer program was used to investigate the effects of sample size, shape, and composition on the amount of energy lost from a monoenergetic neutron beam incident upon one face of the sample. Cylinders, spheres, and rectangular parallelepipeds are considered. The composition calculations confirm that the energy absorbed by compound samples can be calculated with a simple additivity assumption from data obtained for pure element samples, provided the pure element and compound samples are the same size and shape. The effect of sample shape was investigated by calculating the energy lost by monoenergetic neutrons in penetrating cylinders of identical mass but of widely varying thickness and radius. The data indicate that neglect of sample shape can lead to serious errors in the calculation of energy-absorption values. (auth)

6608 (HW-64866(p.56-64)) ASYMPTOTIC SLOWING-DOWN FLUX IN HYDROGENOUS MODERATORS. D. G. Foster, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

In a recent measurement of Fermi age in hydrogenous moderators, the saturated activity of bare and cadmium-covered indium was measured in water and kerosene. The activities were measured out to 35 cm from a spherical Na^{24}–Be source having a diameter of 1.905 cm. Certain features of the flux distributions at large distances from the source are discussed in some detail. (W.D.M.)

6609 (HW-64866(p.88-91)) FAST SOURCE THEORY HARMONIC CORRECTIONS. C. Metelmann and D. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An attempt is made to clarify the equations and normalizing factors used in fast-source-theory harmonic corrections for diffusion length measurements. Fast-source theory is an alternative to the usual cadmium shutter technique in correcting for the effect of the fast neutron source. Fast-source theory calculates the thermal neutron distribution from a fast neutron source, so the fast-source harmonic corrections are applied to bare counter data after substracting the epicadmium neutrons at the counter position. (W.D.M.)

6610 (HW-66215(p.4-10)) DIFFUSION COEFFICIENTS AND DIFFUSION AREAS FOR HETEROGENEOUS SYSTEMS. C. Metelmann and W. C. Finch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

In a new method of calculating the diffusion coefficient for a heterogeneous lattice cell, L^2, the diffusion area for the cell, is considered as a derived quantity; and in the formula, $L^2 = D/\Sigma_a$, the Σ_a differs from the usual flux- and volume-weighted average in a manner which is described. The new method for calculating L^2 and D is compared with the more common method for a simple two-component cell consisting of uranium fuel and graphite moderator. (W.D.M.)

6611 (HW-66215(p.11-13)) INFINITE MEDIUM NEUTRON SLOWING-DOWN DENSITY DUE TO A RING OF LINE SOURCES—COMPUTER PROGRAM QUAD-1. J. R. Lilley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Program QUAD-1 evaluates the neutron slowing-down density inside a ring of equally spaced, infinitely long, line sources, inserted into a moderator of infinite extent. The Fermi Age approximation is used. It is assumed that the contribution from an individual rod is unaffected by the presence of the other rods. The FORTRAN system was used throughout the program, which requires 900 memory locations, exclusive of library subroutines. Input tape 2 and output tape 3 are used. Running time is less than 1 min per case. (auth)

6612 (JINR-D-532) ELASTIC SCATTERING OF γ-RAYS BY DEUTERONS BELOW THE THRESHOLD FOR PION PRODUCTION. L. I. Lapidus and Kuang-chao Chou (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1960. 18p.

The dispersion relations and the unitarity conditions of the S-matrix are used to analyze the elastic γ quanta scattering by deuterons below threshold of pion production. The limit of low energies for γ quanta scattering by nuclei with arbitrary spin is considered. The dependence of the elastic γ-d scattering on energy is obtained with the help of experimental data on deuteron photodisintegration. The result greatly differs from the impulse approximation in a wide energy region. The account of pion photoproduction by deuterons turns out to be negligible in the treated energy range. (auth)

6613 (JINR-D-534) ON THE ANNIHILATION OF ANTIPROTON-PROTON SYSTEM. E. O. Okonov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 6p.

If the matrix of the annihilation transition strongly depends upon the isotopic and spin state of the antiproton-proton system, this may essentially affect the result of the annihilation. In particular, the predominance of the S_0 state in the annihilation may lead to an increase of the average multiplicity of π mesons, whereas the preferential annihilation in the singlet state may suppress the two-meson annihilation. Experiments are suggested to clear up whether dependence really occurs. The possibility is also indicated of checking experimentally whether the capture of the stopped antiproton occurs from the S-orbit in accordance with the estimates made by Day et al., for a K^- meson. (auth)

6614 (JINR-D-535) DETERMINATION OF THE COUPLING CONSTANT OF PION-NUCLEON INTERACTION BY DIFFERENTIAL CROSS SECTION FOR ELASTIC (np)-SCATTERING AT 90, 380-400, 630 MEV. N. S. Amaglobeli, Yu. (Uu.) M. Kazarinov, S. N. Sokolov, and I. N. Silin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.) 1960. 10p.

The determination of experimental data on (np) scattering at 90, 380 to 400, and 630 Mev was carried out in order to determine the coupling constant of pion-nucleon interaction, the existence of two poles in the real part of the (np)-scattering amplitude being taken into account. It is shown that within experimental errors the employed data do not contradict the value $f^2 = 0.08$. (auth)

6615 (JINR-D-547) INTEGRAL EQUATIONS FOR THE π-π-SCATTERING AT LOW ENERGIES. Tso-hsiu Ho, Ding-chang Hsien, and W. Zoellner (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 17p.

The accuracy of the equations of Chew and Mandelstam on π-π scattering in the unphysical region is examined. A new set of equations is derived from the dispersion relation of fixed momentum transfer and the unitarity condition. The equations are quite different from the equations of Chew and Mandelstam with regard to the contributions from the unphysical region. (auth)

6616 (JINR-D-550) APPROXIMATE EQUATIONS FOR PARTIAL π-K SCATTERING AMPLITUDES. P. S. Isaev and M. Sewerynski (Joint Inst. for Nuclear Research, Dubna, U. S. S. R. Lab. of Theoretical Physics). 1960. 19p.

Approximate integral equations for partial π-K scattering amplitudes are obtained with the help of the double Mandelstam representation in the low-energy range. (auth)

6617 (JINR-D-560) ON THE SPIN CORRELATION COEFFICIENT C_{nn} FOR 310 MEV pp-SCATTERING AT 90° (c.m.s.). I. M. Vasilevskiĭ (Vasilevsky), V. V. Vishnyakov, E. I. Iliescu, and A. A. Tyapkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.S.R. Lab. of Nuclear Problems). 1960. 5p.

Results of experiments to determine the phase-shift coefficient are reported. This coefficient determines the correlation between spin components normal to the scattering plane. One experiment was carried out at 320 Mev and led to the value $C_{nn}(90°) = 0.7 \pm 0.3$. Another experiment on the determination of the analyzing ability of carbon scatterers at 160 Mev is also reported in which the value $C_{nn}(90°) = 0.84^{+0.10}_{-0.22}$. (J.R.D.)

6618 (JINR-D-562) INTEGRAL EQUATIONS FOR KN-SCATTERING. Yu. Vol'f (J. Wolf) and W. Zoellner (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 15p.

Starting with the Mandelstam representation, integral equations for the lowest partial waves of K–N and $\bar{K}$–N scattering are obtained on the basis of dispersion relations for forward and backward scattering. In the approximation used, the two systems of integral equations are not coupled. As an estimate for the $d_{5/2}$ wave, an expression is given which depends only on s and p waves. (auth)

6619 (JINR-D-569) ISOTOPIC SPIN CONSERVATION AND PION PRODUCTION, (SURVEY). Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 16p.

The results of several experiments carried out at the JINR synchrocyclotron pertaining to the hypothesis of isotopic spin conservation are discussed. The hypothesis is studied from two angles: (1) to what degree the law of isotopic spin conservation is carried out and whether or not it is a "good" quantum number and (2) what the difference is of interactions in various isotopic spin states. (W.D.M.)

6620 (JINR-D-576) $\pi\pi$ INTERACTIONS IN πN–COLLISIONS AT HIGH ENERGIES OF PIONS. D. I. Blokhintsev and Yung Wang (Joint Inst. for Nuclear Research, Dubna, U. S.S. R. Lab. of Theoretical Physics). 1960. 29p.

The role of π-π interaction in π-N collisions is studied when the momentum of the primary pion is about 7 Bev. It is shown that in elastic π-N scattering the contribution of π-π interaction is not great and that it is fully camouflaged by the diffraction scattering from the nucleon core. In case of inelastic collisions, the contribution of π-π interaction is already quite noticeable and, therefore it is possible to determine the cross sections for π-π interaction from the experimental data on multiple pion production. The distribution of the transverse momentum of the recoil nucleon was calculated in the processes $\pi + N \to N + 2\pi$ and of Λ^0 for the process $\pi + N \to \Lambda^0 + K + \pi$. It is shown that this distribution is in agreement with the experimental data. (auth)

6621 (JINR-D-593) ON PARITY NONCONSERVATION IN STRONG INTERACTIONS INVOLVING STRANGE PARTICLES. Kan-chang Wang, Tzu-tzen Wang, V. I. Veksler, I. (J.) Vrana, Da-tzao Ding, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 6p.

An attempt to detect longitudinal polarization of Λ-hyperons produced in $\pi^- + p$ reactions at 7 to 8 Bev is described. A total of 34,000 pictures were scanned and yielded 208 events of interest. These events are analyzed. (W.D.M.)

6622 (JINR-D-594) PRODUCTION OF Λ AND K^0 IN π^-p INTERACTIONS AT 6.8 ± 0.6 Bev/c. Kan-chang Wang, Tzu-tzen Wang, V. I. Veksler, I. (J) Vrána, Da-tzao Ding, V. I. Ivanov, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 22p.

The processes of Λ (Σ^0) hyperon and K^0-meson generation in π^-p collisions were studied at the π^- meson energy of 6.8 Bev. Cross sections for the production of Λ(Σ^0) and K^0, the relations between the cross sections for the generation of Y^0K and KK pairs, the average multiplicity of charged particles, the angular and momentum distributions of Λ and K^0 in the center-of-mass system, and the distributions of the transverse momenta of Λ and K^0 were obtained. (auth)

6623 (JINR-E-542) ON THE POLARIZATION CROSS-SECTION OF FAST NUCLEON SCATTERING. S. Ciulli and J. Fischer (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 4p.

A discussion of the theoretical interest centered around experimental polarization measurements in elastic small-angle scattering of fast nucleons is presented. (J.R.D.)

6624 (JINR-E-544) PION-NUCLEON SCATTERING AT LOW ENERGIES. [PART] II. A. V. Efremov, V. A. Meshcheryakov, and D. V. Shirkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 12p.

Using the results of a preceding paper, the integral equation for α_{33} and expressions for the other phase-shifts are obtained. The phase-shifts of $\pi\,\pi$-scattering δ_0 and δ_1 in the earlier work are included. The important role of backward πN-scattering dispersion relations is established. The phase-shift δ_0 is shown to influence greatly the πN scattering. The scattering length of δ_0 is evaluated from consideration of the small p-phase-shifts of πN scattering near the threshold. (auth)

6625 (NP-9660) ON THE POSSIBILITY OF MEASURING THE BRANCHING RATIO $R = \frac{(\pi^- + p \rightarrow \pi^0 + \pi^- + p)}{(\pi^- + p \rightarrow \pi^+ + \pi^- + n)}$ AT VERY HIGH ENERGIES. Report No. 161/VII. (O Mozliwości Mierzenia Wielkości $R = \frac{(\pi^- + p \rightarrow \pi^0 + \pi^- + p)}{(\pi^- + p \rightarrow \pi^+ + \pi^- + n)}$ w Obszarze Bardzo Wysokich Energii). A. Krzywicki (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1960. 20p.

The ratio of $R^{(exp)} = \frac{(\pi^- + p \rightarrow \pi^- + p + \pi^0)}{(\pi^- + p \rightarrow \pi^- + \pi^+ + n)}$ to R is calculated for incident pion energies of the order of several Bev. Peripheral pion-nucleon collisions are considered. It is assumed that pion-pion interaction and a possible formation of an intermediate excited nucleon are responsible for the production of additional pions in peripheral pion-nucleon collisions. Experiments are proposed. Some comments on the isotopic properties of the pion-pion interaction are added. (auth)

6626 (NP-9678) SOME ASPECTS OF THE INTERACTION OF ELECTROMAGNETIC RADIATION WITH MANY PARTICLE SYSTEMS (thesis). Narkis Tzoar (Pennsylvania. Univ., Philadelphia). 1961. 114p.

The interaction of electromagnetic radiation with many-particle systems is considered in terms of the total absorption cross section for an electron gas in high density limit and models for the giant dipole resonance in nuclei. (W.D.M.)

6627 (NYO-2780) INVESTIGATION OF APPLICATIONS OF COMPTON BACKSCATTER. MID-TERM STATUS REPORT. K. E. Mears and J. H. Tolan (Lockheed Nuclear Products, [Marietta, Ga.]). Nov. 1960. 20p. Contract AT(30-1)-2428. (NR-114). OTS.

Apparatus for a general study of applications of backscattered radiation was assembled, and data were taken. A modified optical spectrometer stand was utilized to support collimated source and detector housings in uniform relation to the scattering material. This assembly permitted the angle of incidence between the plane of the scattering material and the direction of the source radiation, as well as the angle of scatter between the direction of source radiation and the detector orientation, to be varied independently. The Victoreen linear count-rate meter previously used was modified to shift the position of zero signal so that only the upper portion of the signal appeared on the recording meter. This had the effect of expanding the scale by a factor of three without altering the normal feedback loop for the signal. Preliminary results did not give experimental confirmation to a qualitative conclusion reported in NYO-2779. Specifically the conclusion that the yield will not change substantially for scattering angles greater than 90° was not confirmed for scattering angles between 90 and 140°. Actually a yield increase of several times was observed in this range of scattering angles. Conversely the result experienced when the angle of incidence between the direction of source radiation and the surface plane of the scattering object was adjusted through the range of 20 to 110° was a negligible change. (auth)

6628 (NYO-9364) SPECIAL TOPICS IN DISPERSION RELATIONS. J. C. Taylor. Notes compiled by I. Bialynicki-Birula (Rochester, N. Y. Univ.). Nov. 1, 1960. 92p. Contract AT(30-1)-875. OTS.

A series of lectures on proof of the conventional dispersion relations, the Mandelstam representation, and analytic properties of the scattering amplitude in perturbation theory is presented. (W.D.M.)

6629 (ORNL-3016(p.209-18)) EXAMINATION OF THE RANGE OF APPLICABILITY OF CONDITIONAL MONTE CARLO TO DEEP-PENETRATION PROBLEMS. S. K. Penny and C. D. Zerby (Oak Ridge National Lab., Tenn.).

The conditional Monte Carlo sampling method was applied to the spatial part of a Monte Carlo calculation of the energy spectra and angular distributions from an isotropic point source of γ rays in an infinite medium in which energy degradation was permitted. The purpose was to test the applicability of this technique to problems involving several phase-space variables, since the technique had previously been successfully used in a one-dimensional phase-space computation. Differential energy spectra and angular distributions were computed for two cases—a 1-Mev source in water and an 8-Mev source in lead—for penetrations up to 20 mean free paths (mfp). Comparison with existing moments-method results showed agreement to distances of about 10 mfp. (auth)

6630 (ORNL-3016(p.226-9)) GRINDER: AN IBM 704 MONTE CARLO PROGRAM FOR ESTIMATING THE SCATTERING OF GAMMA RAYS FROM A CYLINDRICAL BEAM CATCHER. D. K. Trubey and S. K. Penny (Oak Ridge National Lab., Tenn.).

The energy spectra and dose rates resulting from scattering of a γ-ray beam incident on a homogeneous right circular cylinder can be obtained from an IBM 704 Monte Carlo program designated GRINDER. A maximum of 20 detector positions is permitted. Results are given as energy spectra histograms from which dose is computed. An important feature of the program is that computing time, rather than number of histories, is an input parameter. The code is being used in the design of a shield for the ORR South Facility. (auth)

6631 (ORNL-3016(p.230-1)) THE SINGLE-SCATTERING APPROXIMATION TO THE GAMMA-RAY AIR SCATTERING PROBLEM. D. K. Trubey (Oak Ridge National Lab., Tenn.).

The result of a calculation using the single-scattering approximation, with no exponential attenuation or build-up, was compared to the result of a Monte Carlo calculation of the dose rate and number flux in air from a monoenergetic γ source. The comparison shows that the simple approximation is generally adequate for unshielded detectors. (auth)

6632 (TID-11288) V–θ COLLISIONS IN THE LEE MODEL. R. D. Amado (Pennsylvania. Univ., Philadelphia). [1960]. 30p. OTS.

The methods of dispersion theory are used to obtain an exact expression for the V-θ elastic scattering amplitude and the amplitude for the production process $V + \theta \rightarrow N + 2\theta$ in the Lee Model. (auth)

6633 (TID-11301) STUDY OF K^+N SCATTERING IN THE DOUBLE DISPERSION REPRESENTATION (thesis). Benjamin W. Lee (Pennsylvania. Univ., Philadelphia). Oct. 1960. 175p. OTS.

K^+-N scattering is studied using the double dispersion representation and stressing the analyticity, crossing relations, and unitarity of the scattering amplitudes. Dispersion relations of the partial wave amplitudes are recorded, and the method for computing the discontinuities across the unphysical branch cuts is shown. An approximate reduction of the double dispersion representation to a single integral representation is carried out, and the physical significance of the resulting representation is explained. (W.D.M.)

6634 (TID-11329) STATISTICAL WEIGHTS IN MULTIPLE PARTICLE PRODUCTION. J. Shapiro (Fordham Univ., New York). [1959?]. 22p. Contract AT(30-1)-2584. OTS.

A closed expression is obtained for the statistical weights of different charge states in multiple particle production, assuming isotopic spin conservation. Tables are given from which the weights may easily be computed. (auth)

6635 (USNRDL-TR-475) PENETRATION OF PLANE NORMAL AND PLANE SLANT GAMMA RAYS THROUGH SLABS OF ALUMINUM AND STEEL. II. ANGULAR AND ENERGY SPECTRA (PHOTON NUMBER FLUX). N. E. Scofield and L. G. Haggmark (Naval Radiological Defense Lab., San Francisco). Oct. 25, 1960. 55p.

Experimentally measured differential energy and angle spectra of the scattered γ-photon number flux are presented for Cs^{137} and Co^{60} source γ rays normally incident upon slabs of aluminum and iron varying in thickness from one to five mean free paths. Spectral measurements for oblique angles of source photon incidence were also made for Co^{60} and slabs of iron with slant thicknesses of two and five mean free paths. Detection angles of 5, 10, 20, 30, 45, and 60° were used. Spectra are compared to show the effects of slab material, slab thickness, source energy, detection and incidence angle as well as the proportion of single and multiple scattering. The results have been normalized to a primary incident flux of one photon cm^{-2} sec^{-1}. (auth)

6636 ON THE WEAK INTERACTIONS. Yasuhisa Katayama (Instituto de Física Teórica, São Paulo, Brazil). Anais acad. brasil. cienc. 32, 195-205(1960). (In English)

The study of weak interactions is important for understanding the natural laws in the realm of elementary particles. The present situation in that branch is summarized and attempts to solve some important problems which are still open, but which may become essential in a near future, are discussed. Experiments concerning the weak interactions and the general theoretical features of these interactions are reviewed. The following are discussed: the universality of the coupling constants of the weak interactions; the maximal concept of weak interactions and their influence on the other interactions; the concept of weak interactions at high energies and the structure of elementary particles; and the origin of parity violation. (auth)

6637 GENERATIONS OF BEAMS OF FAST NEUTRINOS. V. S. Barashenkov and Ting-ch'ang Hsien. Atomnaya Energ. 9, 489-90(1960) Dec. (In Russian)

Neutrino beams generated in π-meson decay were studied in order to establish some characteristics of weak interactions at high energies. Neutrinos of 1 Bev, emitted at Θ_ν angle (almost identical to the π-meson decay angle $\Theta_\nu = 0$), were recorded at various distances from the target. The recorder had a cross sectional area $S_D = 1M^2$. The derived values for neutrino flux at $E > 1$ Bev and $E > 2$ Bev for $\Theta = 0°$ and 3° show very slight dependence on angle. The energy distribution at various distances from the target is plotted and analyzed. (R.V.J.)

6638 SPACE TIME REFLEXIONS, LIGHT QUANTA AND HEAVY BOSONS. H. Frölich (Univ. of Liverpool). Helv. Phys. Acta 33, 803-28(1960). (In English)

An approach to space time reflections leads to the introduction of angular space in terms of which isobaric spin and related quantities find a simple explanation. On the basis of this treatment a wave equation is presented which contains as specific cases the Maxwell equations, and the wave equations for π- and K-mesons. It predicts the existence of a further particle with mechanical spin 1, with the same isobaric spin properties as K-mesons but with a larger rest mass. (auth)

6639 ON THE THEORY OF PARTICLES OF SPIN 1. N. Kemmer (Univ. of Edinburgh). Helv. Phys. Acta 33, 829-38(1960). (In English)

Different formulations of the theory of vector-mesons are discussed. It is shown that the source terms, which can be coupled with a vector-meson, are in general different from the terms which one might naively identify as sources. Usually the true sources include derivatives of field operators, but in exceptional cases, for example in the theory of Yang and Mills, the derivatives do not exist. Such a relation is convenient for renormalization of the theory. (tr-auth)

6640 K-MESON-NUCLEON SCATTERING AND RELATIVISTIC DISPERSION RELATIONS. P. K. Roy (Univ. Coll. of Science, Calcutta). Nuclear Phys. 20, 417-39(1960) Nov. (2). (In English)

Relativistic K-meson-nucleon dispersion relations are subjected to the type of analysis which leads one to expect a resonance in the pion-nucleon system. The P-wave equations for scalar mesons show no indication of any resonance. But the S-wave equations strongly suggest a resonant K^+-p scattering and a repulsive $\bar{K}$-nucleon potential, both in contradiction with experiment. However, for pseudoscalar K-particles, analogous to the pion, the P-wave equations are consistent with a resonance in the $I = 1$, $j = 3/2$ and one of the $I = 0$ states. This conclusion is not borne out by the present experimental findings and calls for detailed information about the angular distributions and the high energy behavior of the scattering cross-section to decide the issue. For the $\bar{K}$ particles no such resonance states are found. For the pseudoscalar K particles it is concluded, in the absence of the "accidental cancellation" which characterizes the pion case, that the $I = 1$ phase-shift at threshold should be given correctly by the "Born" term corresponding to a repulsive interaction, in agreement with experiment. No definitive conclusion about the S-wave behavior of the $\bar{K}$ particles can really be drawn for reasons mentioned below. The main conclusion of the present work is that the dispersion theoretic analysis of nonforward scattering is capable of discriminating between a scalar and pseudoscalar K-meson on qualitative grounds alone; it strongly indicates that these mesons are pseudoscalar. (auth)

6641 THE PHENOMENOLOGICAL BARYON-BARYON SCATTERING THEORY AND THE RELATIVE PARITY DETERMINATION. A. Deloff and J. Wrzecionko (Inst. for Nuclear Research, Warsaw). Nuclear Phys. 20, 464-74 (1960) Nov. (2). (In English)

The reactions $a + b \rightarrow c + d$ with four baryons are considered. Two cases of relative intrinsic parities $I_bI_b = \pm I_cI_d$ are taken into account; the phenomenological S-matrix technique is used for obtaining the cross section and polarizations. An approximation in which in the initial state only the S wave is present and in which the cross section for unpolarized particles is isotropic and the polarizations in the final state are zero when $I_aI_b = I_cI_d$ and proportional to $\sin 2\theta$ when $I_aI_b = -I_cI_d$ is discussed. Some experimental tests for the relative parity determination are proposed. (auth)

6642 LONGITUDINAL POLARIZATION OF BETA-ELECTRONS. P. E. Spivak and L. A. Mikaelian (Kurchatov Atomic Energy Inst., Moscow). Nuclear Phys. 20, 475-86 (1960) Nov. (2). (In English)

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5831.

6643 A NOTE ON $\pi-\pi$ INTERACTION. A. N. Mitra, R. P. Saxena, and P. Narayanaswamy (Muslim Univ., Aligarh (U.P.), India). Nuclear Phys. 20, 491-8(1960) Nov. (2). (In English)

Some qualitative aspects of the $\pi-\pi$ interaction were studied with the help of a simple model which incorporates the essential features of the Bethe-Salpeter integral equation for $\pi-\pi$ interaction as was obtained some time ago. It is found (i) that a contact type ϕ^4 term does not affect the nature of the interaction which is attractive, and (ii) that the energy at which a resonance occurs increases with the effective $\pi-\pi$ coupling parameter. The numerical solutions of the $\pi-\pi$ equations derived by Mitra and Saxena agree qualitatively with these predictions, and suggest that the $I = 0$ interaction (which has a larger coupling parameter) gives a resonance at a much higher energy than $I = 2$. (auth)

6644 NEW ISOTOPIC SPIN SPACE AND CLASSIFICATION OF ELEMENTARY PARTICLES. P. Hillion and J.-P. Vigier (Institut H[enri] Poincaré, Paris). Nuovo cimento (10) 18, 209-28(1960) Oct. 16. (In English)

Beginning with the idea that isotopic spin space is invariant under the group of three-dimensional complex conjugate rotations, this assumption is justified on the basis of a classical model of extended particles described by relativistic rotators. Expressions are given in terms of Euler parameters (a relativistic generalization of real three-dimensional Euler angles) for the infinitesimal operators of the Lie algebra associated with this group and, in the general space of the corresponding eigenfunctions, finite dimensional sub-spaces associated with irreducible representations of the complex rotation group are obtained. In each subspace one then readily defines a set of "isotopic" or "internal state vectors" corresponding to different types of elementary particles so that each particle family is connected with an irreducible representation of this group. In this scheme isotopic strangeness and fermionic numbers correspond to certain infinitesimal rotation operators and one justifies (with qualitative aspects) the empirical Nishijima–Gell-Mann classification of elementary particles. (auth)

6645 HYPERFRAGMENT PRODUCTION IN K^--MESON ABSORPTIONS AT REST IN NUCLEAR EMULSIONS. NON-MESIC DECAYS. J. Sacton (Université Libre, Brussels). Nuovo cimento (10) 18, 266-81(1960) Oct. 16. (In English)

The results of an analysis of 78 nonmesic hyperfragments including double-centered stars produced in K^--meson absorptions at rest are given. The Z-spectrum of the hyperfragments is studied. Twelve decays were uniquely identified and in 6 other cases the charge was unambigously determined. For the remaining events only limits could be put to the charge. Combining the charge distribution with that obtained for the mesic hyperfragments in a previous investigation, the nonmesic to mesic decay ratio is obtained as a function of Z. (auth)

6646 DYNAMICAL CONSEQUENCES OF THE K^+-K^0 MASS DIFFERENCE. G. Frye (Univ. of California, Berkeley). Nuovo cimento (10) 18, 282-6(1960) Oct. 16. (In English)

The possibility of using observed K^+-K^0 mass differences for obtaining information on the $\pi + K$ interaction is investigated. The total isotopic vector charge fraction of the K-meson that resides in the two-pion cloud is the crucial parameter. It must have a value greater than unity to obtain a simple dynamical origin of the mass difference. Consistency requirements arising from the relation to π-K scattering imply that the fraction must have a value of $-2 \lesssim f_K \lesssim 2$. (auth)

6647 $|\Delta S| = 1$, $|\Delta I| = 1/2$ RULES WITH TWO CHARGED INTERMEDIATE BOSON FIELDS. B. d'Espagnat (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 18, 287-303(1960) Oct. 16. (In English)

The rules $|\Delta I| = 1$ for nonleptonic decays and $|\Delta I| = 1/2$ are accounted for by a theory in which weak interactions are due to charged intermediate bosons that have no neutral counterpart. Leptonic decays of strange particles where the total charge of the leptons is zero are thereby forbidden, in accordance with experiment. Observable differences with the prediction of the Lee-Yang theory are discussed. The theory gives arguments for the existence of a decay mode of the cascade particle to a nucleon and leptons with a coupling constant equal to that of the Λ

leptonic decay mode, i.e., with a decay rate about twenty times smaller than the normal Ξ decay rate. (auth)

6648 ON SOME COMPOUND MODELS FOR THE STRONG INTERACTIONS. M. Tonin (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10) 18, 304-15(1960) Oct. 16. (In English)

The possibility that the strongly interacting particles are compound structures of fundamental Majorana fields is investigated in view of their symmetry properties, assuming that the strong interactions possess larger symmetries than the one leading to the baryon number, isotopic spin, and strangeness conservation. The problem of the parity conservation in the theories is discussed. (auth)

6649 THE TWO-BODY PROBLEM IN THE EXTREME RELATIVISTIC LIMIT. K. Baumann and W. Thirring (Universität, Vienna). Nuovo cimento (10) 18, 357-67(1960) Oct. 16. (In English)

In view of the composite model for elementary particles, the two-body problem is studied in the extreme relativistic limit. Spinless particle-antiparticle bound states are investigated for a single massless self-interacting Weyl field. High momenta are suppressed in a Lorentz invariant manner by introducing a heavy auxiliary boson. A Bethe-Salpeter equation is set up in the ladder approximation. The consequences of the continuity equation are studied in the same approximation and are shown to be fulfilled automatically only for scalar bound states. A method is presented for solving the Bethe-Salpeter equation. A spectral ansatz is made for the wave function which leads to a one-dimensional integral equation for the weight function when the rest mass of the bound state is neglected. This integral equation is solved in the Fredholm approximation for a somewhat modified cut-off prescription in the scalar case. With the same restriction, the eigenvalue is found in the pseudoscalar case. It is shown that the method of solution can be extended to any order in the rest mass of the bound state. (auth)

6650 ON A QUADRILINEAR $K^2-\pi^2$ COUPLING. G. Costa (Università, Bari, Italy and Istituto Nazionale di Fisica Nucleare, Padua) and L. Tenaglia. Nuovo cimento (10) 18, 368-80(1960) Oct. 16. (In English)

The effect of the direct K-π coupling on the pion-nucleon and kaon-nucleon inelastic scattering was investigated. The incident boson is assumed to interact only with the peripheral pions of the nucleon cloud. The inelastic scattering cross section is expressed by means of the Chew-Low procedure, in terms of the cross section for the K-π interaction, averaged over the energy. The reliability of the approximation and the branching ratios of the possible reactions are discussed for the various cases. (auth)

6651 RADIATIVE CORRECTIONS TO PAIR PRODUCTION AT HIGH ENERGIES. K. Mork and H. Olsen (Norges Tekniske Hogskole, Trondheim, Norway). Nuovo cimento (10) 18, 395-6(1960) Oct. 16. (In English)

The method of virtual quanta was used to calculate the radiative corrections to the spectral distribution of pair production and bremsstrahlung and to the total pair production cross section. Radiative corrections enter into the final state scattering of emitted photons and as an increase of the virtual quanta number. The first effect is considered by introducing the Compton effect radiative correction cross section into the semi-classical radiation formula. The increase of the virtual quantum number is caused by the vacuum polarization of the nucleus and gives a change in the Bethe-Heitler cross-section form factor. The total pair-production cross section is given for the radiative correction distributions for $k_2 < k_{max}$, where k_{max} is the smallest value of additional final state quantum k_2 detectable. (B.O.G.)

6652 STRUCTURE OF LEPTONS AND MESONS. G. Rosen (Inst. for Theoretical Physics, Stockholm). Nuovo cimento (10) 18, 403-8(1960) Oct. 16. (In English)

A quantum theory is reported for the structure of leptons and mesons in axiomatic fashion without recourse to a classical hamiltonian theory. The structural observables of the particles are defined: lepton number, strangeness number, spin, electric charge, and mass. Physically admissible internal states are determined by subsidiary conditions and wave equations. (B.O.G.)

6653 INERTIAL MOMENT OF LARGE MANY-FERMION SYSTEMS WITH REPULSIVE INTERACTIONS. Ronald M. Rockmore (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 120, 1933-42(1960) Dec. 15. (BNL-4890)

The interaction effects on the moment of inertia of a large many-body fermion system moving under periodic boundary conditions have been explicitly derived in the second order of particle-particle coupling for the case of nonsingular repulsive interparticle forces. The derivation is facilitated by the use of a new hamiltonian constructed by canonical transformation. This transformation is determined by requiring that it remove the compensating effects of pair excitation and that the new interaction operators of first and second order in the cranking field be also of first order in particle-particle coupling. A graphical analysis is presented in which those classes of diagrams which yield corrections vanishing relative to the rigid moment in the limit $L \to \infty$ are distinguished. Some remarks on the related problem of diamagnetism are made. The possible application of the method of canonical transformation to related many-body problems is indicated. (auth)

6654 MOMENTUM DISTRIBUTIONS OF PHOTONS FROM POSITRONS ANNIHILATING IN ALKALI HALIDES. A. T. Stewart and N. K. Pope (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. 120, 2033-41(1960) Dec. 15.

The angular correlation of photons from the two-γ decay of positrons in all sodium halides and all alkali chlorides was measured. The data yield the momentum distribution of the two γ rays which is also the momentum distribution of the annihilating electron-positron pairs. It is seen that the positive ion has very little influence on the momentum distribution in comparison with the negative ion. The distributions in momentum are compared with the distributions calculated from various models of electron and positron wave functions in the crystal. For fluorides and chlorides, the electron-positron wave-function products that yield fits to the experimental data resemble Hartree-Fock free-ion electron wave functions. Both the wave-function products and the free-ion wave functions yield density distributions that are similar to the electron densities obtained by x-ray measurements. This conclusion makes improbable a model of single-particle wave functions, describing both the electrons and the positron tightly bound to the negative ion. (auth)

6655 NEUTRON-PROTON POLARIZATION AND DIFFERENTIAL CROSS SECTION AT 128 MEV. Russell K. Hobbie and Douglas Miller (Harvard Univ., Cambridge, Mass.). Phys. Rev. 120, 2201-6(1960) Dec. 15.

A 42% polarized neutron beam of 128-Mev average energy was used to measure the n-p differential cross section and polarization. A range telescope detected recoil protons from a liquid hydrogen target placed in the beam. The following values were obtained: 169.7θ, 11.37 ± 0.41σ, +0.002 ± 0.021P; 159.3θ, 9.08 ± 0.33σ, −0.045 ± 0.021P; 149.0θ, 7.30 ± 0.26σ, −0.061 ± 0.021P; 138.8θ, 6.28 ± 0.23σ, −0.072 ± 0.017P; 128.5θ, 5.20 ± 0.19σ, −0.016 ± 0.021P; 118.4θ, 4.29 ± 0.15σ, +0.054 ± 0.021P; 108.2θ, 3.45 ± 0.12σ, +0.052 ± 0.025P; 98.1θ, 2.83 ± 0.11σ, +0.186 ± 0.028P; 88.1θ, 2.61 ± 0.09σ, +0.275 ± 0.028P; and 78.1θ, 2.74 ± 0.11σ, +0.384 ± 0.028P. The errors quoted do not include the 7% uncertainty in the normalization of the cross-section data or the 8% uncertainty in the normalization of the polarization data. (auth)

6656 PHASE-PARAMETER REPRESENTATION OF PROTON-PROTON SCATTERING FROM 9.7 TO 345 MEV. G. Breit, M. H. Hull, Jr., K. E. Lassila, and K. D. Pyatt, Jr. (Yale Univ., New Haven). Phys. Rev. 120, 2227-49(1960) Dec. 15.

Results of gradient searches for phase parameters by means of an IBM-704 machine representing proton-proton scattering are reported on, and the procedure used is described. The analysis made use of most available measurements. The number of "measurements" used by the machine was 541. In some cases each "measurement" was a composite of two or more measurements found in the literature. The fits join smoothly to the $^1S_0$ phase-shift energy curve below 9.7 Mev. A family of fits was obtained employing as a starting point the extended source + spin-orbit potential representation below 150 Mev extrapolated to one or another of the several Stapp, Ypsilantis, Metropolis fits at 312 Mev. Other searches started out with phase parameters corresponding to the Gammel-Thaler phenomenological potential. Evidence is presented to the effect that the better fits of both families are essentially the same. Error limits of phase parameters derived are estimated by various procedures. Some of the accumulated evidence for the applicability of the one-pion exchange potential (OPEP) to the calculation of phase parameters for the higher L and J is described and the basis for previously published inferences regarding the spatial extension within which the major part of the potential is the OPEP is illustrated. In the case of the best fit, referred to as YLAM, tests indicating the existence of potentials for separate J were made showing therefore that there is no serious question regarding the energy rates of change of logarithmic derivatives of radial wave functions being negative. A brief discussion of the relationship of this requirement to the meson theory of nuclear forces is included. (auth)

6657 THEORY OF LOW-ENERGY NUCLEON-NUCLEON SCATTERING. M. L. Goldberger (Princeton Univ., N. J.), M. T. Grisaru, S. W. MacDowell, and D. Y. Wong. Phys. Rev. 120, 2250-76(1960) Dec. 15.

The two-nucleon problem is discussed from the standpoint of the double dispersion relations. The analytic structure of partial wave amplitudes was completely analyzed. This was greatly facilitated by the use of the Jacob-Wick helicity amplitudes. The program of generating a set of dynamical equations by use of the unitarity condition was carried out. In the present approximation only one- and two-pion exchanges were considered; the resulting system of equations should be adequate for energies below about 170 Mev. The problem of computing the deuteron parameters is discussed. The general structure of the more complicated nucleon-antinucleon system is briefly treated. (auth)

6658 MEASUREMENT OF THE g FACTOR OF FREE, HIGH-ENERGY ELECTRONS. A. A. Schupp, R. W. Pidd, and H. R. Crane (Univ. of Michigan, Ann Arbor). Phys. Rev. 121, 1-17(1961) Jan. 1.

100-kev electrons in 0.1-μsec bunches are sent into a gold foil. The part of the electron bunch which is scattered at right angles, and which, consequently, is partially polarized, is trapped in a magnetic field and held for a measured length of time (up to 300 μsec). The bunch is then released from the trap and allowed to strike a second gold foil. Counters receive the electrons scattered at plus and minus approximately 90°. The cycle is repeated 1000 times per sec. The asymmetry in intensity in the two directions depends upon the final direction of polarization. A plot of the intensity asymmetry as a function of trapping duration is a cosine curve, whose frequency is the difference between the orbital frequency and the spin precession frequency. This is related to the g factor as follows: $\omega_p m_0 c/Be = a$, where g is $2(1 + a)$. Thus the "anomaly," a, is measured directly. The determination of B presents some difficulty because the field must be slightly nonuniform in order to trap the electrons. The spatial variation in B from the center of the trap to the ends is only 0.3%, and the time average of B which applies to the trapped electrons is evaluated to 0.1%. Measurements made at electron energies down to 50 kev, showed a slight dependence of a upon energy. The dependence is attributed to electrostatic charges on the surfaces in the trapping region. The final standard error quoted is, however, purposely made large enough so that the variation of a with energy is bracketted. The result is a = 0.0011609 ± 0.0000024. (auth)

6659 BINDING ENERGY OF THE DEUTERON MEASURED WITH A BENT CRYSTAL SPECTROMETER. Edward L. Chupp, Raymond W. Jewell, Jr., and Walter John (Univ. of California, Livermore). Phys. Rev. 121, 234-5 (1961) Jan. 1.

The binding energy of the deuteron was determined by measuring the energy of the neutron-proton capture gamma ray with a 2-meter bent quartz crystal spectrometer in the Cauchois geometry. A polyethylene target in the through-tube of a reactor supplied the n-p capture gamma rays. The 411.77-kev gamma ray of Hg^{198} and the annihilation radiation were used to calibrate the spectrometer. The average of the results of four plates gives 2.225 ± 0.003 Mev for the binding energy of the deuteron. (auth)

6660 DYNAMICS OF INTERNALLY CONVERTED ELECTRON-POSITRON PAIRS. N. P. Samios (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 121, 275-81(1961) Jan. 1.

The reactions studied were $\pi^- + p \rightarrow n + \pi^0$ ($\pi^0 \rightarrow \gamma + e^+ + e^-$) and $\pi^- + p \rightarrow n + e^+ + e^-$. From a sample of ~15000 internally converted electron-positron pairs, 7000 were measured, of which 4200 were used in the detailed analysis. The differential distributions in y (the energy partition) and x^2 (the virtual mass of the photon) agree with the theoretical quantum electrodynamic calculations. A measure of the form factor for the $\pi^0 \rightarrow 2\gamma$ reaction gave a value $\Gamma(x/\mu) = 1 - (0.24 \pm 0.16)x^2/\mu^2$, where μ is the mass of the pion. It was further demonstrated that the number of events necessary to determine the contribution of the longitudinally polarized virtual γ rays in the second reaction is of the order of 50 times that in the present experiment. (auth)

6661 $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ AND THE $\Sigma^0 - \Lambda^0$ RELATIVE PARITY. Nina Byers (Stanford Univ., Calif.) and Hugh Burkhardt. Phys. Rev. 121, 281-2(1961) Jan. 1.

The $\Sigma^0 - \Lambda^0$ relative parity may be measured by observing correlation of polarizations in the process $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. Internal conversion of the photon into an electron pair (Dalitz pair) serves as an analyzer which selects polarized photons. Theoretical results are presented which show that the Dalitz-pair decay mode of polarized Σ^0's may be used to measure the $\Sigma^0 - \Lambda^0$ relative parity. (auth)

6662 EFFECTS OF THE PION-PION RESONANCE AND THE THREE-PION RESONANCE OR BOUND STATE ON NEUTRAL-PION DECAY. How-sen Wong (Univ. of California, Berkeley). Phys. Rev. 121, 289-90(1961) Jan. 1. (UCRL-9333)

The dispersion method was applied to the problem of neutral-pion decay. It is shown that a pion-pion P-wave resonance can produce a large effect in the decay matrix element. The contribution is related to the semifundamental constant which determines the rate of photoproduction of pions from pions. The contribution of a strong three-pion state is considered. (auth)

6663 POSSIBLE EFFECT OF $\overline{K} - N$ REACTIONS ON K-N SCATTERING. Richard H. Capps (Argonne National Lab., Ill. and Cornell Univ., Ithaca, N. Y.). Phys. Rev. 121, 291-3(1961) Jan. 1.

Approximate P-wave dispersion relations for K-N scattering are considered, under the assumption that the KΛN and KΣN interactions are of the odd intrinsic-parity, Yukawa type. If the crossing terms (which involve the P-wave $\overline{K} - N$ amplitudes) are neglected, the predictions of the equations are contradicted by the experimental evidence. The presence of virtual pion-hyperon states may enhance the $\overline{K} - N$ amplitudes sufficiently that they play an important role in the equations. It is shown that if the isotopic spin 1, $P_{1/2}$ $\overline{K} - N$ absorptive amplitude is particularly strong, the contradiction with experiment may be removed. The possibility of even-parity K-baryon reactions is discussed. (auth)

6664 DEPOLARIZATION OF NEGATIVE μ MESONS. R. A. Mann and M. E. Rose (Oak Ridge National Lab., Tenn.). Phys. Rev. 121, 293-301(1961) Jan. 1.

The depolarization of negative μ mesons is discussed in terms of the processes occurring in the formation of μ-mesonic atoms and the subsequent cascade to the ground state. The initial distribution of μ mesons in capturing states of carbon is deduced. The depolarization from the capture process is derived free of essentially all approximations. The only assumption involved is that the scattering cross section is such as to randomize the direction of motion prior to capture and this assumption is shown to be well fulfilled. The effect of radiative transitions in producing depolarization is determined with all possible dipole transitions taken into account. Only nuclei with zero spin are treated in detail. The Auger process is included in a schematic fashion which is sufficient for the purpose in hand. It is shown that both radiative and Auger transitions must be included in the discussion of the depolarization processes in the cascade. The theoretical results are compared with experiment, and from the comparison it is concluded that the observed facts are well accounted for. (auth)

6665 NONLEPTONIC DECAY MODES OF THE HYPERONS. G. Feldman, P. T. Matthews, and A. Salam (Imperial Coll. of Science and Tech., London). Phys. Rev. 121, 302-3(1961) Jan. 1.

A correlation is made of the observed asymmetries in hyperon decays and the hyperon decay times using a pole approximation to the decay matrix elements. It is found that a natural correlation is obtained if a near-global relation between pion coupling constants is assumed. (auth)

6666 RENORMALIZATION CONSTANTS IN QUANTUM ELECTRODYNAMICS. Paul C. DeCelles (Johns Hopkins Univ., Baltimore). Phys. Rev. 121, 304-11(1961) Jan. 1.

The electron self-energy and wave-function renormalization constants are calculated using the technique of dispersion relations. To do this, exact representations of these renormalization constants are obtained in terms of matrix elements of Heisenberg field operators. The matrix element $\langle e\gamma|\bar{\psi}|0\rangle$ is studied and its contribution to the renormalization constants determined. In retaining only the contributions due to $\langle e|\bar{\psi}|0\rangle$ and $\langle e\gamma|\bar{\psi}|0\rangle$ an infinity of other matrix elements is ignored. A test of the validity of this approximation is discussed. Within the limits of the approximations, the self-energy and wave-function renormalization constants are shown to have a logarithmic, ultraviolet divergence. The wave-function renormalization constant also has an infrared divergence. (auth)

6667 K_2^0 AND THE EQUIVALENCE PRINCIPLE. Myron L. Good (Univ. of Wisconsin, Madison). Phys. Rev. 121, 311-13(1961) Jan. 1.

It is shown that the existence of the long-lived neutral K meson, and the absence of its decay into two pions, establishes that the gravitational masses of the K^0 and $\overline{K}^0$ are equal to a few parts in 10^{-10} of the K inertial mass. This is of interest since the $\overline{K}^0$ is the antiparticle of the K^0, and is not identical with the K^0. The gravitational mass of such a nonidentical antiparticle has never been directly measured. The $\overline{K}^0$ has opposite strangeness to the K^0. Thus the argument rules out any linear dependence of the gravitational mass on the strangeness quantum number, a point on which all previous experiments say nothing. These observations are in accord with, and serve as a confirmation of, the equivalence principle of Einstein. (auth)

6668 TOTAL COMPTON CROSS SECTION FOR ARBITRARY SPIN. C. G. Bollini (Imperial Coll. of Science and Tech., London). Phys. Rev. 121, 314-18(1961) Jan. 1.

The magnitude of the total Compton cross section for arbitrary spin is calculated in lowest order by using the absorptive part of the forward scattering amplitude and the unitarity property of the S matrix. To find the general form (for any spin) of the forward amplitude a universal electromagnetic interaction, implying the value 2 for the gyromagnetic ratio, is postulated. The deduced cross section contains as special cases the known cross sections for spinless and Dirac particles. The average of the cross section over all the possible polarization states of the particle is performed. In the high-energy region the cross section never increases faster than linearly with the energy of the photon. If a development in powers of the photon energy is made, the first and second coefficients are found to be spin independent. The coefficient of the square of the energy is proportional to the square of the modulus of the spin vector. (auth)

6669 WEAK-COUPLING CURRENTS AND SYMMETRIES OF STRONG INTERACTIONS. R. E. Behrends (Inst. for Advanced Study, Princeton, N. J.) and A. Sirlin. Phys. Rev. 121, 324-36(1961) Jan. 1.

The general isotopic properties of bilinear currents which will lead to the $|\Delta S| \leq 1$ and $|\Delta I| = \frac{1}{2}$ rules for weak decay processes are examined. The latter rule is re-expressed in terms of an equivalent mathematical statement which permits one to obtain the usual predictions in a simple manner. In general, when the strangeness-conserving part of such a current is an isotopic vector, the strangeness-changing part can be a linear combination of $I = \frac{1}{2}$ and $I = \frac{3}{2}$ currents. The existence of an $I = \frac{3}{2}$ current could be established by experiments on the decays $K \rightarrow \pi +$ leptons, or on high-energy neutrino capture, $\nu + N \rightarrow \mu + \Sigma$. Experiments on K_{e4} decays could test the bilinearity of the current. The assumption that the vector part of such a current, both strangeness changing and non-changing, is quasi-conserved (i.e., neglecting certain mass differences) in the presence of the strong interactions fixes the specific form of the current and further implies symmetries for the strong couplings. The various transformations which leave invariant a Yukawa-type strong interaction as well as their associated currents are found. A new possible symmetry group of the strong interactions is examined: a 14 parameter group usually denoted as G2. In the presence of both π and K couplings, it is found that $I = \frac{1}{2}$ and $\frac{3}{2}$ currents are quasi-conserved when the strong Lagrangian has a 7-dimensional rotational symmetry, while for the $I = \frac{3}{2}$ alone, the symmetry required is G2. In the presence of only π-baryon couplings, only $I = \frac{1}{2}$ currents can be quasi-conserved. Certain predictions for the K_{e3} and K_{e4} modes of decay and for $\Sigma^- \rightarrow n + e^- + \nu$ follow from the weak currents determined in this way. (auth)

6670 SOME SINGULARITIES OF SCATTERING AMPLITUDES ON UNPHYSICAL SHEETS. J. Gunson and J. G. Taylor (Univ. of Cambridge, Eng.). Phys. Rev. 121, 343-6(1961) Jan. 1.

An investigation of the consequences on unphysical sheets of a Mandelstam-type representation holding for a two-particle scattering amplitude on the physical sheet is described. The domain of analyticity in the energy and momentum transfer variables is constructed and compared with perturbation theory. A theorem on multiplication of singularities for Legendre polynomial expansions used in the discussion is proven. (auth)

6671 STRUCTURE OF THE S MATRIX IN THE PRESENCE OF A BOUND STATE. Smio Tani (Washington Univ., Saint Louis). Phys. Rev. 121, 346-9(1961) Jan. 1.

It is shown that the phase factor associated with the "orthogonality phase shift" from a bound state should be factored out of the S matrix. A crucial test of this statement is found in a study of the final state interaction of an inelastic process which ends in a channel involving the bound state. If it is assumed that the sum of the Born series for the S matrix gives a right answer after the effect of the bound state is separated in terms of the orthogonality phase shift, an agreement with Watson's result obtains only when the S matrix has the factored structure. (auth)

6672 MASS AND LIFETIME OF UNSTABLE PARTICLES. R. Jacob and R. G. Sachs (Univ. of Wisconsin, Madison). Phys. Rev. 121, 350-6(1961) Jan. 1.

The relationship between the properties of the propagator of an unstable particle and the observation of mass and lifetime is considered. For illustrative purposes a model of a scalar (or pseudoscalar) particle (θ) weakly coupled to two pions is treated. The propagator is shown to have a simple pole on the second (unphysical) Riemann sheet and it is assumed, as suggested by Peierls, that this is generally the case. By analysis of a prototype experiment in terms of wave packets, it is shown that the measured mass and lifetime are determined by the real and imaginary parts of the pole, respectively. Nonexponential terms occur in the lifetime curve, as is well known. These are shown to be related to the uncertainty in the time of the production or detection event under normal circumstances. This conclusion is similar to those of Lévy and of Schwinger, but more closely related to experimental conditions. In particular it is found that the wave packets introduce a "mass filter" in a somewhat different manner from that suggested by Schwinger. Under special conditions a $t^{-\frac{1}{2}}$ term may occur in the amplitude but would be unimportant in magnitude for, say, the decay of a strange particle. It is noted that such nonexponential decay curves might occur for certain low-energy nuclear processes. Consideration is given to the treatment of two degenerate, unstable particles, such as the neutral K mesons. The general method for handling the problem leads, in the weak-coupling limit, to the same result as the Wigner-Weisskopf method. (auth)

6673 EXPERIMENTAL VERIFICATION OF RADIATION OF PLASMA OSCILLATIONS IN THIN SILVER FILMS. Wulf Steinmann (Universität, Munich). Phys. Rev. Letters 5, 470-2(1960) Nov. 15.

Self-supported silver films were bombarded with 25-kev electrons to study the radiation of plasma oscillations in the films. A quartz spectrograph with a resolution of 10 mμ was used to record radiation from the film. The radiation spectra was found to consist of a rather sharp line at 330 ± 10 mμ and a broad continuum at the long-wavelength side of the line; for the shorter wavelengths, the intensity falls rapidly to zero. The dependence of the intensity on film thickness was studied as an experimental test of whether the radiation was really caused by plasmons. Experimental results demonstrate that the dependence of the line intensity on thickness agrees with theoretical prediction; showing two maxima between 0 and 200 mμ thickness, the second one much lower than the first, and the minimum equal to zero between them, while the intensity of the continuum apparently shows another dependence on thickness. As a result it is demonstrated that plasmons really can radiate, and that in silver plasmons exist with $\hbar\omega\rho = 3.75 \pm 0.1$ ev. (B.O.G.)

6674 QUANTITATIVE EVIDENCE OF ONE-PION EXCHANGE EFFECTS IN p-p SCATTERING. Peter S. Signell (Pennsylvania State Univ., University Park). Phys. Rev. Letters 5, 474-6(1960) Nov. 15.

A further analysis was made of the data reported by Morovcsik, et al., concerning phase-shifts in 310-Mev p-p scattering, because it was felt that the significance of those results was considerably marred by the appearance of two strikingly different low angular-momentum phase-shift sets. Both of the sets have approximately the same behavior under variations of the theoretical coupling constant. The coupling constant was fixed at $g^2 = 12.0$, and 9-parameter searches were conducted. The "goodness-of-fit" parameter χ^2 values are given as a function of virtual quantum mass for the Harvard 95-Mev data and for sets 1 and 2 of MacGregor et al. data at 310 Mev. The 95-Mev minimum is a ~125-Mev quantum mass, and the pion mass is ~135 Mev. The two solutions at 310 Mev exhibit an exceedingly poor behavior under quantum mass variations; the curves are far from parabolic and the minima are far from the physical value. It is concluded that: (a) the 95-Mev Harvard p-p scattering data sharply exclude the numerical values of the theoretical coupling constant and virtual quantum mass

from being very different from corresponding values for the real pion, thus providing quantitative evidence of the one-pion exchange force used by MacGregor, et al.; and (b) conclusions previously deduced from the 310-Mev data are made uncertain, probably basically from the lack of good enough data. (B.O.G.)

6675 POSSIBLE EXISTENCE OF $\Delta Q = -\Delta S$ DECAYS. R. E. Behrends (Brookhaven National Lab., Upton, N. Y.) and A. Sirlin. Phys. Rev. Letters 5, 476-8(1960) Nov. 15.

An examination was made of the experimental implications of $I = {}^3/_2$ and $I = {}^1/_2$ currents. The existence of $I = {}^3/_2$ currents of strongly interacting particles coupled to the leptonic currents permits, but does not demand, the presence of leptonic modes of decay with $\Delta Q = -\Delta S$ (while preserving the rule $|\Delta S| \leq 1$ for all decays), while these decays are forbidden for pure $I = {}^1/_2$ currents. It follows from the existence of the K_{l2} decay that $I = {}^1/_2$ currents must be present in the space-time vector and/or axial vector part. Considerations are given for the study of K_{l3} decays consisting of pure or dominant $I = {}^3/_2$ currents, and assuming time-reversal invariance. Inequalities are given which hold exactly for the e^+ and μ^+ modes and for the total rates for positive leptons, electron plus muon. Inserting the existing experimental data, the total decay rate is obtained for the leptonic modes, e plus μ : $8.5^{+2.3}_{-1.6} \geq [R(K^0 \to \pi^+ + \text{leptons})]/[R(K^0 \to \pi^- + \text{leptons})] \geq 0.85^{+0.81}_{-0.45}$. The equalities for the total rates, r and s, of the electron modes are obtained by assuming that the form factor for the $(K^0_2)_{e3}$ and $(K^+)_{e3}$ decays have approximately the same dependence on E_π : $r_+ = 4.2^{+0.8}_{-0.7}$; $r_- = 0.00^{+0.05}_{}$; $s_+ = 8.5^{+2.3}_{-1.6}$; and $s_- = 0.85^{+0.81}_{-0.45}$. The value of r_+ is in close agreement with existing data, but the experimental errors are too large at present to draw any definite conclusions. (B.O.G.)

6676 REACTION $\mu + N \to e + N'$: INTERMEDIATE BOSON THEORY. Frederick J. Ernst (Columbia Univ., New York). Phys. Rev. Letters 5, 478-80(1960) Nov. 15.

An investigation was conducted on the dependence of predicted branching ratios, for processes of μ^- bound in a 1S state around a nucleus, upon the value of high-momentum cutoff and the Boson mass. The processes investigated were: $\mu \to e + \nu + \bar{\nu}$; $\mu \to e - \gamma$; and $\mu + N \to e + N'$. Feynman graphs are given which contribute to the $\mu - e - \gamma$ matrix element in the lowest order of perturbation theory. For any cutoff less than four or five times the Boson mass, the rate for $\mu \to e + \gamma$ is compatible with the experimental branching ratio $\omega(\mu \to e + \gamma)/\omega(\mu \to e + \nu + \bar{\nu}) < 2 \times 10^{-6}$. The branching ratio for the $\mu + N \to e + N'$ reaction is given for various choices of cutoff Λ for the Boson anomalous moment $\mu = 0.7$ magneton. The branching ratio for $\mu = 0$ and cutoff equal to the Boson mass $\omega(\mu + N \to e + N')/\omega_{abs} \approx 2 \times 10^{-6}$. For an anomalous moment of 0.7 Boson magneton and for a cutoff equal to the Boson mass, the branching ratio is $\omega(\mu \to 3e)/\omega(\mu \to e + \nu + \bar{\nu}) \approx 2 \times 10^{-8}$. (B.O.G.)

6677 PARTIALLY CONSERVED CURRENTS AND THE K′ MESON. Jeremy Bernstein (Brookhaven National Lab., Upton, N. Y.) and Steven Weinberg. Phys. Rev. Letters 5, 481-3(1960) Nov. 15.

Suggestions have been made concerning the existence of a strong S-wave $T = {}^1/_2$ K-π resonance, which can be thought of as a "particle" similar to the K-meson. Three reasons are given for suspecting the existence of such a K′ meson which must decay by strong coupling and for which the parity is even. Considerations are given which show how the K′ particle may appear in the $\Delta S = 1$ leptonic decay processes, assuming the divergence $\partial^\lambda J^\nu_\lambda$ to be a "gentle" operator. All properties of $K_{\mu 3}$ and K_{e3} decay are determined by two scalar form factors $f_v(q^2)$ and $g_v(q^2)$. It is seen that the K′ "pole" can appear only in $g_v(q^2)$, and not in $f_v(q^2)$. It is not certain whether this resonance gives the dominant contribution for the range of q^2 in K_{e3} and $K_{\mu 3}$ decay. The present results are instructively compared with those of Weinberg et al., who assumed that J^ν_λ was actually conserved. (B.O.G.)

6678 INTERPRETATION OF THE BERKELEY ANOMALY IN HIGH-ENERGY p-d COLLISIONS. Arnold Tubis and Jack L. Uretsky (Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters 5, 513-14(1960) Dec. 1.

An explanation of the peak in the momentum spectrum of the final nucleus (He^3 or T) observed in Berkeley experiments on double-pion production in p-d collisions at a momentum corresponding to a total energy of ~310 Mev of the two pions is offered in which the statistical method is generalized to allow for p-wave scattering between the final-state pions. The scattering length is chosen to give a production cross section maximum at about 300-Mev two-pion energy and found to be ~2.5 pion Compton wavelengths. It is concluded that it is not necessary to postulate a resonance to explain the Berkeley bumps. The possibility of a two-meson bound state is discussed. (D.L.C.)

6679 PHOTOPRODUCTION OF NEGATIVE PIONS FROM HYDROGEN AT FORWARD ANGLES. J. R. Kilner, R. E. Diebold, and R. L. Walker (California Inst. of Tech., Pasadena). Phys. Rev. Letters 5, 518-20(1960) Dec. 1.

Bremsstrahlung of energy 1230 Mev with an interval of 100 Mev was used to produce π^- in a liquid hydrogen target, data being taken at laboratory angles from 5 to 30° and π^- laboratory momenta from ~600 to 1000 Mev/c. Plots of the differential cross section vs. total energy for several angles and of the angular distribution are compared with Drell's theoretical results; the agreement is qualitatively good, although the experimental cross sections are considerably larger and do not show any decrease at the smallest angle measured. (D.L.C.)

6680 RESONANCE IN THE $\Lambda\pi$ SYSTEM. Margaret Alston, Luis W. Alvarez, Philippe Eberhard, Myron L. Good, William Graziano, Harold K. Ticho, and Stanley G. Wojcicki (Univ. of California, Berkeley). Phys. Rev. Letters 5, 520-4(1960) Dec. 1.

The reaction $K^- + p \to \Lambda^0 + \pi^+ + \pi^-$ was studied using 1.15-Bev/c K^- mesons in a 15-in. H_2 bubble chamber; of the total 255 events found, 141 were chosen to represent the reaction although 10 to 15% of them are estimated to be actually Σ^0 events. The energy distribution of the two pions on a Dalitz plot shows a nonuniform distribution of the points with peaks near 285 Mev. This distribution is consistent with a quasi-two-body reaction of the type $K^- + p \to Y^{*\pm} + \pi^\mp$ (1), where Y^* has a mass spectrum peaking at ~1380 Mev and breaks up in this way $Y^{*\pm} \to \Lambda^0 + \pi^\pm$; 59 Y^{*+} and 82 Y^{*-} events were observed, using the criterion that the high-momentum pion is the pion from reaction (1). Production angular distributions for Y^{*+} and Y^{*-} in the K^-p rest system are given. An attempt was made without success to determine the spin of Y^* by analyzing its angular momentum, the relations between its decay angle and the polarization of the resulting Λ, and its anisotropy. The possibility that Y^* corresponds to a resonance in pion-hyperon scattering was studied by fitting a p-wave resonance formula to the $\pi\Lambda$ data; the results were compared with those of Gell-Mann and Watson for the 3-3 resonance and found to be similar. (D.L.C.)

6681 SOME CONSIDERATIONS ON THE RECENTLY FOUND EVIDENCE FOR A $\pi\Lambda$ RESONANCE. D. Amati, B. Vitale (European Organization for Nuclear Research, Geneva) and A. Stanghellini. Phys. Rev. Letters 5, 524-6 (1960) Dec. 1.

The predictions of the model for pion-hyperon interactions in the case of equal Λ and Σ parities are examined in the light of evidence for a $\pi\Lambda$ resonance in the $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ reaction. The model predicts two resonant states (T = 1 and 2) for $J = 3/2$. Since the T = 1 resonance is present in both the $\pi\Lambda$ and $\pi\Sigma$ channels, the branching ratio for the decay of Y^* for $\pi\Lambda$ and $\pi\Sigma$ states is calculated and found to be in qualitative agreement with experiment. The results predicted for the $\pi\Lambda$(T = 1) resonance also agrees with experiment. The possibility of other resonances are considered. The results support the assumption of equal Λ-Σ parity and the assignment of spin $3/2$ to the observed resonance. (D.L.C.)

6682 SEARCH FOR RESONANCE IN π-π INTERACTION IN π-N SCATTERING AT 0.96 Bev. J. G. Rushbrooke and D. Radojičič (Cavendish Lab., Cambridge, Eng.). Phys. Rev. Letters 5, 567-70(1960) Dec. 15.

Photographs of a hydrogen bubble chamber exposed to 0.96-Bev mesons(π^-) were analyzed for interactions, and 110 events of the type $\pi^- + p \rightarrow p + \pi^- + \pi^0$ were found and examined for evidence of a resonance in the π-π interaction. The data were put in the form of proton kinetic energy spectra and event spectra vs ω^2/μ^2; the latter was resolved into a number of separate ω^2/μ^2 regions and compared with the statistical model and the Chew-Low results. Only in one region was evidence found of a π-π resonance, and it is concluded that further work is needed. (D.L.C.)

6683 π^+-PROTON SCATTERING CROSS SECTIONS BY CHEW-LOW EXTRAPOLATION. G. A. Smith, H. Courant, E. Fowler, H. Kraybill, J. Sandweiss, and H. Taft (Yale Univ., New Haven). Phys. Rev. Letters 5, 571-2(1960) Dec. 15.

A 20-inch hydrogen bubble chamber exposed to 2.85-Bev protons yielded 790 examples of $p + p \rightarrow p + n + \pi^+$, which were used along with the Chew-Low extrapolation technique to estimate the total π^+-p cross section at various energies. This estimation was made in the $62 \leq Q \leq 226$-Mev region, where the π^+-p cross section peaks in the $3/2$-$3/2$ resonance at 154 Mev to ~200 mb, and the $226 \leq Q \leq 793$-Mev region where the cross section falls from ~100 to 20 mb. The resulting cross sections have the correct relative magnitudes. (D.L.C.)

6684 NEUTRINO EMISSION FROM BLACK-BODY RADIATION AT HIGH STELLAR TEMPERATURES. Hong-Yee Chiu (Inst. for Advanced Study, Princeton, N. J.). and P. Morrison. Phys. Rev. Letters 5, 573-5(1960) Dec. 15.

In addition to the three neutrino emission processes possible at high temperatures $\geq 10^{10}$°K (urca, neutrino bremsstrahlung, and photoneutrino), there are two other processes more rapid at most densities and at temperatures 10^{9}°K: (1) pair-annihilation neutrinos ($e^- + e^+ \rightarrow \nu + \bar{\nu}$) and (2) photon-photon neutrinos ($\gamma + \gamma \rightarrow \nu + \bar{\nu}$). Feynman diagrams of these processes are given, and the rate of loss of energy density is calculated for the processes in various temperature and density regions. The relaxation time for cooling by neutrino loss is estimated to be between 10^{9} and 10^{15} seconds. The effects of neutrino emission on stellar matter are discussed. (D.L.C.)

6685 TOTAL CROSS SECTIONS OF PROTONS WITH MOMENTUM BETWEEN 10 AND 28 Gev/c. A. Ashmore, G. Cocconi, A. N. Diddens, and A. M. Wetherell (European Organization for Nuclear Research, Geneva). Phys. Rev. Letters 5, 576-8(1960) Dec. 15.

Total proton cross sections were measured for protons and neutrons using a proton beam of momentum between 10 and 28 Bev/c. The p-p cross sections are in good agreement with earlier results and show a constancy at ~40 mb over the entire momentum range. Absorption proton cross sections were measured at 24 Bev/c for Be, C, Al, Cu, Cd, and Pb; the results fit an $A^{2/3}$ law except for the lighter elements. (D.L.C.)

6686 A π RESONANCE AND POSSIBLE DETERMINATION OF THE KYN PARITIES. Marc Ross (Università, Rome) and Gordon Shaw. Phys. Rev. Letters 5, 578-80 (1960) Dec. 15.

An attempt is made to describe the 1380-Mev Λ-π resonance reported from experiments on the reaction $K^- + p \rightarrow \Lambda + \pi^- + \pi^+$ in terms of a quasi-bound state of the isotopic spin I = 1, s-wave $\bar{K}N$ system. Possible tests of the association of the $\Lambda\pi$ resonance with the $\bar{K}N$ s-state are given, and the possibility of determining the KYN parity by means of the orbital angular momentum of the resonant $Y\pi$ state is discussed. (D.L.C.)

6687 UNIFIED APPROACH TO HIGH- AND LOW-ENERGY STRONG INTERACTIONS ON THE BASIS OF THE MANDELSTAM REPRESENTATION. G. F. Chew and S. C. Frautschi (Univ. of California, Berkeley). Phys. Rev. Letters 5, 580-3(1960) Dec. 15.

An approach to the theory of strong interactions which treats high- and low-energy phenomena in a unified manner is presented based on the Mandelstam representation and using the π-π interaction as an example. A Mandelstam diagram for π-π elastic scattering is discussed in detail; inelastic processes are also considered. The asymptotic behavior of cross sections and diffraction peaks is treated. The result is that in the low-energy elastic region the P-wave interaction should be strong and bound states for $J \geq 2$ are produced. (D.L.C.)

6688 INVESTIGATION OF THE FIVE-POINT FUNCTION. L. F. Cook, Jr. and Jan Tarski (Univ. of California, Berkeley). Phys. Rev. Letters 5, 585-8(1960) Dec. 15.

An investigation of the singularities of Feynman amplitudes for production processes was carried out. The investigation was restricted to single-loop diagrams without crossed lines and one configuration of momenta for four specific processes. The results are plotted as singularities in the complex p_{23}^2 plane, and the effects of the five-point poles on the processes are discussed. (D.L.C.)

6689 TESTS OF FORM OF THE ONE-PION EXCHANGE POTENTIAL. G. Breit, M. H. Hull, Jr., K. E. Lassila, and H. M. Ruppel (Yale Univ., New Haven). Proc. Natl. Acad. Sci. U. S. 46, 1649-57(1960) Dec.

The mathematical form of the one-pion exchange potential (OPEP) is tested by comparison with experimental material on nucleon-nucleon scattering. The tests are performed by modifying the form following from meson theory through changes in the proportions of spin-spin and tensor parts of the potential and also by adding a central potential part. These two tests are performed independently of each other, and in each case, the pion-nucleon coupling constant is allowed to vary simultaneously with the modifying parameter. Proton-proton and proton-neutron data are

treated independently of each other. The experimental material is in the region of 9 to 340 Mev. Within the statistical error of the determination, the best values of the parameters are not significantly different from zero as long as the conditions for the applicability of the OPEP are satisfied through exclusion of too low values of orbital angular momentum $L\hbar$. A definite deviation appears in tests of the central potential when L = 4 is admitted into the OPEP group of singlet even potentials. The absence of a definite effect for the proportion of spin-spin and tensor parts in tests performed fits expectation for the two-pion exchange potential. (auth)

6690 CIRCULAR POLARIZATION OF BREMSSTRAHLUNG FROM LONGITUDINALLY POLARIZED PRIMARY ELECTRON. Haridas Banerjee (Indian Inst. of Tech., Kharagpur). Proc. Natl. Inst. Sci. India. Pt. A, 26, 502-6 (1960) Sept. 26. (In English)

The estimation of bremsstrahlung circular polarization is considerably simplified if the primary electron is considered to be longitudinally polarized. It has been shown that for relativistic energy and small angle approximation, an idea may be derived of both the sense and the magnitude of the circular polarization of the bremsstrahlung without making use of any explicit representation of the γ matrices and subsequent expansion of the matrix elements. From the generality of the arguments it would also be apparent how, under similar restrictions, this method can be employed in considering the polarization phenomena in other processes; e.g., the photo-electric effect in the K-shell. (auth)

6691 SYMMETRIES OF THE INTERACTIONS AMONG STRONGLY INTERACTING PARTICLES AND NON-LEPTONIC DECAYS OF HYPERONS. Kanji Fujii (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto) 24, 259-70(1960) Aug. (In English)

A symmetry law that can hold true in both strong and weak interactions among the strongly interacting particles is investigated, and an example is given. The requirement of the variance under the proposed symmetry transformation and some assumptions lead to the interactions that give consistent results with experiments of Σ_+ and Λ decays. The implications of such a symmetry law are discussed and the problems concerning the K-meson decay into two pions are mentioned. (auth)

6692 ON A MODEL OF NUCLEON STRUCTURE AND MESON-NUCLEON INTERATION. [PART] I. Hiroshi Nakamura (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto) 24, 271-90(1960) Aug. (In English)

The problems of π-nucleon collision and nucleon-antinucleon annihilation are treated using a phenomenological model in which the existence of the repulsive core for nucleon-nucleon potential and the attractive core for nucleon-antinucleon potential is assumed. The results give rather good agreement with experimental evidence, not only with respect to π-nucleon collision, but also to nucleon-antinucleon annihilation. (auth)

6693 LAGRANGIAN FORMALISM FOR A CLASSICAL RELATIVISTIC PARTICLE ENDOWED WITH INTERNAL STRUCTURE. Francis Halbwachs (Institut Henri Poincaré, Paris). Prog. Theoret. Phys. (Kyoto) 24, 291-307 (1960) Aug. (In English)

The problem of the classical motion of a relativistic particle is treated with classical mechanics in variational form; a single particle traveling in an external field along a definite curved line in space-time is assigned a Lagrangian and internal variables to express its proper rotation. General conservation equations are derived and applied to the case of the relativistic spinning particle moving classically in an electromagnetic field. Equations are also derived for the precession velocity of the spin in an electromagnetic field. (D.L.C.)

6694 UNIVERSALITY OF COUPLING CONSTANTS AND INDIVIDUAL Γ_5-INVARIANCE. Kenzo Iwata (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto) 24, 308-16(1960) Aug. (In English)

The characteristics of the interaction of elementary particles are summarized as " universality" and a sort of invariance which is called "individual Γ_5-invariance." The fact that these are the requisites of forthcoming theories is pointed out. The limit of applicability of (V-A) type-weak interaction in the high-energy region is also discussed. (auth)

6695 PHOTODISINTEGRATION OF THE DEUTERON AT HIGH ENERGIES. Tomoya Akiba (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto) 24, 370-85(1960) Aug. (In English)

The exchange-current effects in the photodisintegration of the deuteron at high energies are discussed. Special consideration is given to correlation of the exchange effects with the large direct E1 transition, whose behavior has been the object of the recent several investigations; consequences of gage invariance for the electric transitions due to exchange effects; and evaluation of the magnetic transition caused by the (33)-resonance in terms of the results of the Chew-Low theory. It is shown that exchange effects affect the electric dipole transition operator in a way consistent with the Siegert theorem. The resulting change in the electric dipole cross section is evaluated in the adiabatic approximation as well as in neglect of higher order retardation effect. It is appreciable only at photon energies above the pion threshold. Some characteristics of the (33)-resonance effect are revealed, although nucleon recoil effects and uncertainty of nuclear force make it difficult to give any quantitative estimation. Finally the results obtained here are compared with experiment. (auth)

6696 COUPLING OF DIRAC PARTICLE AND GRAVITATIONAL FIELD. Toshiei Kimura (Hiroshima Univ.) Progr. Theoret. Phys. (Kyoto) 24, 386-406(1960) Aug. (In English)

By using legs connection the general relativistic Dirac equation that is invariant under the general coordinate transformations and spin transformations is investigated. The four-dimensional representation for the generalized Dirac matrices is obtained by introducing the six legs and the concept of sedenion conjugate. It is shown that Fermi-Fermi interaction term must be added to the original Lagrangian density if the legs connection is regarded as an independent field quantity; the electromagnetic field is introduced in connection with the complex legs; and the relation between the spin transformation and Pauli-Gürsey type transformation is considered. (auth)

6697 INFORMATION ABOUT THE PROTON-PROTON SCATTERING MATRIX FROM COULOMB INTERFERENCE. B. P. Nigam (Univ. of Rochester, N. Y.). Progr. Theoret. Phys. (Kyoto) 24, 407-13(1960) Aug. (In English). (NYO-9032).

It is shown that a measurement of the p-p scattering parameters at very small angles and angles close to π where Coulomb interference is important will directly determine

the coefficients of the scattering matrix. Since the coefficients are known functions of the phase shifts, such measurements may rule out some of the phase-shift solutions and may provide a unique set of phase shifts. (auth)

6698 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. V. NUMERICAL RESULTS OF THREE-PION-STATE CONTRIBUTIONS. Kichiro Hiida and Noboru Nakanishi (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 414-17(1960) Aug. (In English)

Numerical results of the 3π-state contributions to the isoscalar part of the electromagnetic structure of the nucleon are presented in the no-loop approximation of relativistic perturbation theory. They are compared with the previous results obtained on other approximations. (auth)

6699 S-WAVE PION-NUCLEON PHASE SHIFTS. Kin-ichi Ishida (Yamagata Univ., [Japan]). Progr. Theoret. Phys. (Kyoto) 24, 459-60(1960) Aug. (In English)

The effects of the P-wave cloud surrounding the nucleon core on the Hamiltonian for the S-wave interaction between pions and nucleons are estimated using Chew-Low static theory and Miyazawa's technique, and an expression is obtained which agrees with that of Chew, Goldberger, Low, and Nambu. However, the $\alpha_1 + 2\alpha_3$ phase shift calculated from the Hamiltonian does not agree with either that of Chew et al. or the observed shift. A possible cause of the low observed shift is discussed. (D.L.C.)

6700 AN EXAMPLE OF A SCATTERING SYSTEM IN JAUCH'S SENSE. Shige Toshi Kuroda (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto) 24, 461-2(1960) Aug. (In English)

A quantum mechanical system consisting of two particles moving in one-dimensional space and having two channels is shown to be an example of a scattering system whose scattering operator describes the scattering process completely, as defined by Jauch. The system of a finite number of particles in which the individual Hamiltonians have each a finite number of bound states is also considered. (D.L.C.)

6701 LOW SCATTER HIGH CURRENT GAS TARGET FOR D-D NEUTRONS. Allan C. B. Richardson (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instr. 31, 1202-3(1960) Nov.

A target for the production of neutrons by the $D(d,n)He^3$ reaction is described. The target gas is circulated to cool the foils used as entrance and exit windows for the incident deuteron beam. Low mass construction is employed to minimize the scattering of neutrons. (auth)

6702 EXPERIMENTAL STATUS OF THE NUCLEON-NUCLEON INTERACTION. R. Wilson (Harvard Univ., Cambridge, Mass.). p.47-64 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Basic experimental knowledge of the nucleon-nucleon interaction is summarized. In measurements of proton-proton scattering at any given low energy, only the S-state phase shift could be determined because the wavelength of the colliding particles was large compared with the interaction distance. At higher energies, the differential cross section, the polarization dependence of the cross section, the depolarization or spin flip parameter, and the spin rotation parameter were measured. At 1 Bev and above, meson production was found to be predominant and all phase shifts became complex. An optical model for the proton with the scattering caused entirely by absorption was developed. In studies of neutron-proton scattering, the effective range and potential depth in triplet and singlet states were determined. All data were analyzed assuming parity conservation and time reversal invariance. (M.C.G.)

6703 P-P ANGULAR DISTRIBUTIONS FROM 10 TO 68 MEV AND VARIATION OF 90° CROSS-SECTIONS WITH ENERGY. Lawrence H. Johnston (Univ. of Minnesota, Minneapolis). p.65-9 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Angular distributions of proton-proton scattering were measured over the energy range 10 to 68 Mev. At 10 Mev the angular distribution differed little from pure S-wave scattering. A detailed analysis of the 40-Mev distribution indicated the presence of finite phase shifts through F-waves. At 68 Mev the higher order waves appeared in important amounts. Measurements of the 90° p-p cross sections were also made as a function of energy. (M.C.G.)

6704 MEASUREMENT OF R PARAMETER AT ~140 MEV. L. Bird, D. Edwards, B. Rose, A. E. Taylor, and E. Wood (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.71-2 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Measurements of the Wolfenstein R parameter for proton-proton scattering at 140 Mev were made for scattering angles between 11 and 35°. A 46% polarized beam from the cyclotron passed down the axis of a solenoid which rotated the spin vector about the beam direction into the horizontal plane. It was then focused on a hydrogen target. The state of polarization of the beam scattered in the horizontal plane was analyzed in an up-down asymmetry measurement by scattering from beryllium at 12°. Values obtained for R varied from −0.105 to −0.199. (M.C.G.)

6705 DETERMINATION OF THE TRIPLE SCATTERING PARAMETER R AT 210 MEV. E. Heer, J. Tinlot, W. Gibson, and A. England (Univ. of Rochester, N. Y.). p.73-7 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The rotation parameter R was measured in a triple scattering experiment. The proton beam from a synchro-cyclotron was scattered at 15° from a carbon target. This scattered beam, about 90% polarized, was focused on a second target of liquid hydrogen. The polarization of the second scattered beam was measured with a polarimeter which made use of the left-right asymmetries observed in the scattering of polarized protons by carbon. Results of the present determination of R at 210 Mev were compared with earlier measurements at 310 and 140 Mev. (M.C.G.)

6706 PHASE-SHIFT ANALYSIS OF PROTON-PROTON SCATTERING. J. K. Perring (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.93-6 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

A phase-shift analysis was made of proton-proton scattering at 140 Mev taking into account the nine phase shifts up to F-waves. The computed cross section and polarization curves were almost identical for all solutions. (M.C.G.)

6707 NEUTRON-PROTON ANGULAR DISTRIBUTIONS AND POLARIZATION MEASUREMENTS IN THE

ENERGY RANGE 20 TO 120 MEV. P. H. Bowen, G. C. Cox, G. Huxtable, A. Langsford, J. P. Scanlon, G. Stafford, and J. J. Thresher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.99-106 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Neutron-proton angular distributions and polarizations were measured in the energy range between 20 and 120 Mev. The measurements were designed to cover the entire angular range by detecting the scattered neutrons at angles between 0 and 90° and the recoil protons at angles between 90 and 180°. The proton measurements provided relative values of the cross sections only. These were put on an absolute scale by normalizing to the neutron results in the region where the two sets overlapped. Results are shown in a series of graphs. (M.C.G.)

6708 DISPERSION RELATION FOR NUCLEON-NUCLEON SCATTERING AT MODERATE ENERGY. Y. Hara and H. Miyazawa (Tokyo Univ.). p.171-3 of "Nuclear Forces and the Few-Nucleon Problem, Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The dispersion relation for nucleon-nucleon forward scattering is discussed. Both the one-pion-exchange and two-pion contribution are included so that the relation can be used for higher energies. This dispersion relation was used for analyzing proton-proton data. Results are given in both tabular and graph form. (M.C.G.)

6709 THE IMPULSE APPROXIMATION IN NUCLEON-DEUTERON SCATTERING. L. Castillejo and L. S. Singh (Univ. of Birmingham, Eng.). p.193-202 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The impulse approximation for the scattering of a neutron by a deuteron is given. This expression is convenient since the form factor only appears in the differential cross section and cancels out completely in the polarization and in the expectation values of all the other spin operators. The expression, therefore, provides a good method for studying the interference of the amplitudes scattered from the neutron and proton in the deuteron. Results indicated that the impulse approximation can explain all the present experiments on n-d or p-d scattering at high energies and small angles. (M.C.G.)

6710 ELASTIC SCATTERING OF HIGH-ENERGY NEUTRONS BY DEUTERONS AT 90 MEV. Yoshiyuki Sakamoto and Tatuya Sasakawa (Kyoto Univ.). p.207-12 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

An experimental check was made of the impulse approximation in n-d scattering, and a test of the proposed nuclear phase shifts was carried out. The differential cross section for n-d elastic scattering was represented by a product of the sticking factor and the absolute square of the sum of the two-body scattering amplitudes, or dynamical factor. The meson theoretical phase shifts were used to calculate the dynamical factor. The deuteron wave function, also given by the meson theory, was used to calculate the sticking factor. The sticking factor and differential cross section for 90 Mev n-d elastic scattering were calculated and compared with experimental results. (M.C.G.)

6711 COLLISION CROSS-SECTIONS OF THE DEUTERON AT HIGH ENERGIES. R. J. Glauber (Harvard Univ., Cambridge, Mass.). p.233-40 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

A number of effects are considered which lead to a difference between the high energy cross sections of the deuteron and the sum of the corresponding cross sections of a free neutron and proton. Particular attention is paid to the role of double scattering, which is chiefly responsible for explaining the cross section difference at energies below the meson production threshold. A simple analysis is given of the error made by the impulse approximation in neglecting the effects of double scattering. (auth)

6712 DISPERSION RELATIONS AND NEUTRON-DEUTERON SCATTERING. M. L. Goldberger (Princeton Univ., N. J.), Francis R. Halpern, and R. Blankenbecler. p.241-4 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The process of elastic neutron-deuteron scattering is discussed from the standpoint of dispersion theory. Aside from the appearance of anomalous thresholds, there seem to be no difficulties in principle, although no derivation of the relations was attempted. The problems of the anomalous thresholds were ignored, a procedure which could be very dangerous for reasons discussed. Certain features of the process, such as the pick-up peak in the backward direction and a corresponding peak due to a "compound nucleus" type of graph, appear quite neatly and the general occurrence of such phenomena is briefly discussed. The theory was developed for the general nonforward elastic scattering but the only application was to forward scattering at low energies where phase-shift analyses were available. The agreement with experiment is satisfactory. (auth)

6713 THE ELASTIC SCATTERING OF PROTONS BY α-PARTICLES AT $E_{lab} = 40$ AND 95 MEV. A. Herzenberg (Univ. of Manchester, Eng.) and E. J. Squires. p.249-55 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The scattering of incident nucleons by alpha particles was calculated with a simple Gaussian central two-body potential. First and second order Born approximations for scattering were calculated for energies of 40 and 95 Mev, with the α particle constrained to the ground state. The Coulomb interference region, forward and backward peaks, and a kink in the 95 Mev experimental curve at 55° are discussed. (M.C.G.)

6714 CLOUD CHAMBER STUDY OF p-α COLLISIONS AT 53 MEV. D. J. Cairns, T. C. Griffith, G. J. Lush, A. J. Metheringham, and R. H. Thomas (Univ. Coll., London). p.269-76 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The cloud chamber used in studying p-α collisions at 53 Mev is described. A scintillation counter selection system was used to trigger expansion only when an incident proton was scattered in the gas of the chamber. About 1400 p-α collisions were measured and analyzed in three main categories: coplanar two-prong events consisting of elastic p-α collisions and inelastic collisions from the reaction $He^4(p,d)He^3$; noncoplanar two-prong

events from the $He^4(p,pn)He^3$ reaction; and three-prong events which involved several inelastic p-α reactions. The polarization in p-α elastic scattering was determined from a measurement of the left-right asymmetry in the horizontal plane. (M.C.G.)

6715 p-d SCATTERING AT 140 MEV. M. J. Esten, T. C. Griffith, G. J. Lush, A. J. Metheringham, and C. P. van Zyl (Univ. Coll., London). p.277-9 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

An analysis was made of about 1000 photographs of p-d collisions obtained in a cloud chamber. All the collisions appeared as two-prong events. The elastic collisions were identified by the coplanarity test and range-angle correlations. The analysis of the inelastic collisions was devoted to those events involving at least one proton of energy less than 8 Mev. The angular distribution of protons did not appear to be isotropic. It was peaked forward at 90°. (M.C.G.)

6716 ENERGY SPECTRUM OF FORWARD NEUTRONS FROM p-d COLLISIONS AT 142 MEV. P. H. Bowen, G. C. Cox, G. Huxtable, A. H. Langsford, J. P. Scanlon, and J. J. Thresher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.281-3 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The neutron energy spectra at 0° was measured in p-d scattering at 142 Mev. To look at this spectra a subtraction was made between LiO and LiH targets. The difference spectrum showed a monoenergetic neutron peak at 140 Mev with a tail extending down to low energies. The peak energy was compatible with the mean incident proton energy less the deuteron binding energy. (M.C.G.)

6717 DEUTERON DISINTEGRATION IN d-p SCATTERING AT 23 MEV. Karl W. Brockman, Jr., and Wilhelmus T. H. van Oers (Inst. for Nuclear Research, Amsterdam). p.285-90 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The scattering of deuterons by a hydrogen gas target was investigated. Scattered deuterons and protons were detected in a NaI scintillation counter and the spectra were recorded with an R.I.D.L. 100-channel kicksorter. The absolute cross section was determined at 17° with an accuracy of the order of 4% by scattering simultaneously from a gold foil target and the hydrogen gas target. Break-up spectra were obtained at laboratory angles between 6.7 and 45°. The cross section for disintegration, about 600 mb, was unusually large, three or four times greater than any previous estimate based on experiment. (M.C.G.)

6718 CALCULATIONS ON THE PHOTO-DISINTEGRATION OF THE DEUTERON. G. Breit (Yale Univ., New Haven). p.311-22 of "Nuclear Forces and the Few-Nucleon Problem. Volume I." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Measurements and calculations were made of the photo-disintegration of deuterons to test views of nucleon-nucleon forces and the electromagnetic properties of nucleons. An arrangement of the calculation is presented by means of which the inclusion of higher multipoles and changes in assumptions regarding potentials may be quickly taken into account. The arrangement is being programed for an IBM 704. An amplitude method similar to that used in the nucleon-nucleon phase-shift analysis was used. Comparison with experiment showed the presence of systematic deviations at lower energies. (M.C.G.)

6719 RECENT EFFORTS AT LOS ALAMOS TO INTEGRATE THE n-d SCATTERING EQUATIONS EXACTLY NUMERICALLY. G. Baker, J. Gammel, and J. Wills (Los Alamos Scientific Lab., N. Mex.). p.357-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Two-body problems were solved by a method in which the scattering equations were integrated forward in time. The method can be modified to give correct results in the presence of a bound state. Three-body problems were solved in which the three particles were "distinguishable" nucleons and the ordinary potential was a square well deep enough to bind the deuteron properly. (M.C.G.)

6720 SCATTERING AND POLARIZATION OF 3.27 MEV NEUTRONS BY DEUTERONS. M. Brüllman, H.-J Gerber, D. Meier, and P. Scherrer (Physikalisches Institut der ETH, Zurich). p.359-63 of "Nuclear Forces and the Few-Nucleon Problem. Volume." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The differential cross section and the polarization for the scattering of 3.27-Mev neutrons by deuterons were measured. The results were compared with other data and with theory. (M.C.G.)

6721 POLARIZATION IN PROTON-DEUTERON SCATTERING. M. Shafroth (Northwestern Univ., Evanston, Ill.), R. Chalmers, E. N. Strait, and R. E. Segel. p.365-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Polarization of the protons elastically scattered from deuterium was measured by observing the left-right asymmetry in a double scattering experiment. The protons were first scattered by deuterium and the scattered protons at selected angles were once more scattered by helium. Then they were detected by thin CsI(Tl) crystals. Results showed almost no polarization of the protons. (M.C.G.)

6722 n-d SCATTERING LENGTHS. S. I. Rubinow (Stevens Inst. of Tech., Hoboken, N. J.) and L. Sartori. p.385-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

When neutron-deuteron scattering lengths were calculated by means of a new variation method, two sets of values were obtained: (1) $a_4 = 6.4f$, $a_2 = 0.7f$; and (2) $a_4 = 2.6f$, $a_2 = 8.3f$. In comparison with experimental data it was found that the doublet scattering was in agreement with neither set, although the quartet scattering length was closer to that of the first set. A revision in the variation principles suggested by Spruce and Rosenberg led to striking improvement in the values of a_4. (M.C.G.)

6723 ON THE SCATTERING OF NEUTRONS WITH DEUTERONS. G. Skorniakov (Skornyakov) (Academy of Sciences, Moscow). p.389-93 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Equations for determining the amplitudes for neutron-deuteron scattering were derived for the case of finite range forces. An iteration is proposed for the solution of the equations. It was assumed that the energy of the incident particle was sufficiently small and that only elastic scattering was possible. The problem was solved for three identical spinless particles. (M.C.G.)

6724 THE GROUND STATE OF THE TRITON. G. Derrick and J. M. Blatt (Univ. of Sydney). p.395-7 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The dependence of the triton wave function on angle, spin, and isotopic spin variables was analyzed. The behavior of the "radial" parts of the wave function in various special regions of configuration space was explored. (M.C.G.)

6725 FEASIBILITY OF SPIN CORRELATION MEASUREMENTS IN ELASTIC SCATTERING EXPERIMENTS INVOLVING FEW NUCLEONS. J. L. Gammel (Los Alamos Scientific Lab., N. Mex.). p.451-4 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Experiments by which the correct set of p-d scattering lengths can be determined are discussed. The spin correlation parameter was determined for p-d scattering in which the recoil proton and deuteron were then scattered from He^4. The spin correlation can also be measured by scattering polarized incident particles from polarized targets. (M.C.G.)

6726 SPIN INTERACTIONS IN T-α AND D-α SCATTERING PROCESSES. J. E. Brolley, Jr., L. Stewart, and L. Rosen (Los Alamos Scientific Lab., N. Mex.). p.455-60 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Experiments were carried out to determine whether mass three nucleons experience spin-orbit interaction similar to that manifested in proton or neutron scattering by He^4. The differential cross sections were measured for T-α and He^3-He^4 scattering at 11, 13, 22, 25, and 28 Mev. A phase shift analysis was made of the low-energy T-α angular distributions. Polarization was calculated from the best fit phase shift. Several further experiments are discussed. (M.C.G.)

6727 POLARIZATION MEASUREMENTS IN p-α ELASTIC SCATTERING. Mary Jean Scott (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.461-6 of "Nuclear Forces and Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The polarization to be expected in p-α elastic scattering can be calculated from the angular distribution when the correct set of phase shifts is chosen. The phase shifts are assumed to be independent variables in the calculation. In the energy region 1.4 to 4 Mev the angular distribution was measured and the polarization calculated. A very rough extrapolation of the phase shifts to energies below 1.4 Mev yielded a maximum polarization of 30 to 40% at 1 Mev. (M.C.G.)

6728 EXPERIMENTAL DATA ON LOW-ENERGY NEUTRON SCATTERING AT LOS ALAMOS. L. Cranberg (Los Alamos Scientific Lab., N. Mex.). p.473-80 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The scattering of neutrons by light nuclei below 10 Mev was investigated. Chief interest was in measurements of n-T and n-He^3 scattering. In both processes the calculated curves for the Serber exchange force were in much better agreement with the data than the results of the symmetrical exchange mixture. A series of measurements of the differential scattering cross sections was made with monoenergetic neutrons in the range from 1 to 6 Mev, using He^3 gas at high pressure and CaT_2 as scatterers. Neutron polarization measurements were also made. Evidence for an excited state in He^4 at about 22 Mev was examined. (M.C.G.)

6729 THE USE OF POLARIZED DEUTERONS IN THE D-D REACTION. J. R. Rook and L. J. B. Goldfarb (Univ. of Manchester, Eng.). p.571-3 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The use of polarized deuterons as bombarding particles in the reactions $D + D \rightarrow He^3 + p$ and $D + D \rightarrow He^3 + n$ at energies less than $\frac{1}{2}$ Mev is considered. Assuming only S- and P-wave deuterons, it is shown that the angular distributions associated with these processes, when supplemented by existing experimental information, would provide an almost complete determination of the reaction matrix. In particular, it would be possible to detect the existence of singlet to triplet transitions. It is pointed out that the reaction matrix could be completely determined with polarized deuterons by measurement of the outgoing polarization. (auth)

6730 LIGHT PARTICLE REACTIONS. J. M. LeBlanc (Univ. of California, Livermore). p.595-608 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960. (UCRL-5578)

The absolute differential cross sections for neutron production by means of the D(d,n)He^3 reaction at energies of 5.0, 7.6, 9.6, and 12.2 Mev were measured. Relative angular distributions were measured first and then normalized to the subsequently measured absolute cross sections at zero degrees. A fitting of the data was made by means of the stripping theory. The energy spectra of neutrons from the d-d and p-d break-up reactions were measured by the time-of-flight method. (M.C.G.)

6731 PROTON-PROTON AND PROTON-DEUTERON SCATTERING AT 14 MEV. S. Kikuchi, J. Sanada, S. Suwa, I. Hayashi, K. Nisimura, and S. Fukunaga (Tokyo Univ.). p.669-70 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The angular distributions of proton-proton scattering at 14.10 Mev and proton-deuteron scattering at 13.93 Mev were measured. The differential elastic scattering cross sections were also determined for the proton-deuteron interactions. (M.C.G.)

Neutron Physics

6732 (CF-60-5-145) FLUX PROGRAM FOR THE IBM 704. V. O. Haynes and B. D. Williams (Oak Ridge National Lab., Tenn.). May 5, 1960. 18p. OTS.

Monitor activation theory leading to the basic relation between the monitor weight and activity and the neutron flux is presented. Manipulations to convert the theory into a form suitable for machine computation and details concerning programing, accuracy, range, usage, and costs are included along with a sample case. (auth)

6733 (CF-60-9-122) SOLUTION OF THE MONOENERGETIC BOLTZMANN EQUATION IN AN INFINITE HOMOGENEOUS NONMULTIPLYING MEDIUM WITH LINEARLY ANISOTROPIC SCATTERING AND AN ISOTROPIC PLANE SOURCE. Erdal Inönü (Oak Ridge National Lab., Tenn.). Sept. 6, 1960. 10p. OTS.

The solution of the monoenergetic Boltzmann equation in an infinite homogeneous nonmultiplying medium with linearly anisotropic scattering and an isotropic plane source is given and compared with the corresponding solution for isotropic scattering. The effective source strength for the asymptotic flux turns out to be the same as that for isotropic scattering to first order in Σ_s/E. (auth)

6734 (GAMD-1347) PROGRAM FOR THE ESTIMATES OF RESONANCE INTEGRALS. Carl Crafton and J. D. Garrison (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 5, 1960. 11p. Project No. 40. Contract AT(04-3)-187. OTS.

A program is described for estimation of neutron resonance integrals. The program was prepared in connection with the reactor physics calculations for the Maritime Gas-cooled Reactor. Programming method, flow chart, and operating instructions are given. (W.D.M.)

6735 (NARF-60-8T(Vol.I)) MONTE CARLO CALCULATIONS OF FAST-NEUTRON SCATTERING IN AIR. M. B. Wells (Convair, Fort Worth, Tex.). May 13, 1960. 84p. Contract AF33(600)-38946. (FZK-9-147(Vol.I)).

The results of a Monte Carlo calculation of the scattering of fast neutrons in an infinite homogeneous medium of air are presented. The results of these calculations, which include the effect of inelastic scattering, are presented in terms of angular distributions, energy spectra, and tissue dose rates at source-detector separation distances of from 10 to 100 ft. A parameter study was completed for source energies of 0.33, 1.1, 2.7, 4, 6, 8, 10.9, and 14 Mev and source angles with respect to the source-detector axis from 5 to 180°. A description is given of the Monte Carlo problem and the mathematical procedures used in the calculations. Graphs giving the distribution of the scattered flux and dose rate as a function of source energy, source angle, and source-detector separation distance are included. Tables that give the energy distribution of the air-scattered flux also are included. (auth)

6736 (NP-9659) THE SLOWING DOWN OF NEUTRONS AS A STOCHASTIC PROCESS. (Spowalnianie Neutronów Jako Proces Stochastyczny). Report No. 159/IX. Z. Weiss (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1960. 20p.

The solution of the neutron slowing down equation in an infinite homogenous moderator (with nuclei of mass M) is obtained by means of direct summation of transition probabilities between the initial and final energy states. It was possible to get an exact formula for the distribution of neutrons in lethargy space after N collisions with moderator nuclei. The asymptotic expansion of the results for large and very large N is in agreement with the Dancoff formulas. The accuracy of the asymptotic expansion is estimated. (auth)

6737 (ORNL-3016(p.142-8)) DETECTOR TECHNIQUES USED IN THE MEASUREMENT OF THE SLOWING DOWN OF FISSION NEUTRONS IN WATER. T. V. Blosser and D. K. Trubey (Oak Ridge National Lab., Tenn.).

The use of indium foils as detectors in determining the slowing-down distribution in water of neutrons from a fission source was studied. The principal reactions resulting from bombardment of natural indium by neutrons were evaluated. Both β- and γ-ray counting techniques are discussed, and a method by which contributions from indium resonances other than the principal resonance at 1.45 ev may be estimated is given. (auth)

6738 (ORNL-3016(p.151-3)) ON THE VALIDITY OF THE SECOND FUNDAMENTAL THEOREM IN A MEDIUM WITH ANISOTROPIC SCATTERING. L. Dresner (Oak Ridge National Lab., Tenn.).

The second fundamental theorem of reactor theory states that a good estimate of the nonleakage probability from a bare reactor is given by the Fourier transform of the infinite-medium kernel evaluated at the asymptotic buckling of the reactor. Inönü has investigated the validity of this theorem for the one-velocity slab reactor with isotropic scattering by means of a variational technique. He finds its use gives very good results even for quite small reactors with dimensions of the order of a few mean free paths. The effect of anisotropy in the scattering on the validity of the theorem is investigated by a variation-iteration technique. It is concluded that the theorem is, in general, less reliable the more anisotropic the scattering. (auth)

6739 (ORNL-3016(p.183-7)) AN IBM 704 CODE FOR THE CALCULATION OF MOMENTS. I. M. Happer and W. E. Kinney (Oak Ridge National Lab., Tenn.).

An IBM 704 code is being written which uses the moments method to compute the even moments, from zero to the tenth, of the flux and the slowing-down distribution of neutrons from a plane source. The portion of the code which computes and stores the kernels was written and tested. The main code, which solves the group moment equation for the moments of the flux, was written but not yet tested. (auth)

6740 (ORNL-3016(p.187-8)) A TREATMENT OF TIME-DEPENDENT SLOWING-DOWN OF NEUTRONS, USING GROUP THEORY. E. Guth and E. Inönü (Oak Ridge National Lab., Tenn.).

The Wigner application of group theory to multiple scattering problems was employed to obtain the distribution function describing the time-dependent slowing down of neutrons through elastic collisions. For the special case of no absorption and spherically symmetric scattering in the center-of-mass system, the solution reduces to an exact expression. (auth)

6741 (ORNL-3016(p.188-9)) THE EFFECT OF THE BOUNDARY REGION IN THE DETERMINATION OF THE EXTRAPOLATION LENGTH FROM EXPERIMENTS WITH CRITICAL CYLINDERS. E. Inönü (Oak Ridge National Lab., Tenn.).

Experimental determinations of the extrapolation length obtained from vertical traverses in bare homogeneous critical assemblies of aqueous U^{235} solutions were analyzed. It is shown that the apparent differences between thermal-, epithermal-, and fast-neutron extrapolation lengths are due entirely to boundary region effects. By excluding points within 3 in. of the boundary, a consistent unique extrapolation length is obtained. A similar treatment is successful with fluxes obtained from Corn Pone calculations. (auth)

6742 (ORNL-3016(p.189-90)) ON RANDOM WALK INTERPRETATION OF LINEAR BOLTZMANN EQUATIONS. E. Guth and E. Inönü (Oak Ridge National Lab., Tenn.).

An exact connection between the recurrence relations defining random walks and the linear Boltzmann integro-differential equations is demonstrated. Application to

problems of neutron transport, Brownian movement, and neutron thermalization is suggested. (auth)

6743 (ORNL-3016(p.190)) SOLUTION OF THE MONOENERGETIC BOLTZMANN EQUATION IN AN INFINITE HOMOGENEOUS MEDIUM WITH LINEARLY ANISOTROPIC SCATTERING FOR AN ISOTROPIC POINT SOURCE. E. Inönü (Oak Ridge National Lab., Tenn.).

The monoenergetic Boltzmann equation in an infinite homogeneous medium with linearly anisotropic scattering and an isotropic point source was solved exactly by the method of Fourier transforms. (auth)

6744 (ORNL-3016(p.202-9)) ANGULAR DISTRIBUTION OF NEUTRONS EMERGING FROM PLANAR SURFACES OF DIFFUSING MEDIA. V. V. Verbinski (Oak Ridge National Lab., Tenn.).

Measurements of the angular distribution of low-energy neutrons emerging from the surface of hydrogenous slabs indicate that the angular distribution not only follows the $\phi(\mu) = 1 + \sqrt{3}\,\mu$ dependence given by Bethe for pure paraffin but also is independent of the poison content for the range investigated, the slab thickness (after spectral equilibrium is reached), and the angle of incidence of the input neutrons. Measurements for a non-slowing-down medium (lead) indicate that the angular distribution is more strongly peaked in the forward direction when the medium is poisoned. (auth)

6745 (UCRL-6112) THE SCATTERING OF NEUTRONS FROM POLYCRYSTALLINE MATERIALS. W. Marshall and R. N. Stuart (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1960. 23p. Contract W-7405-eng-48. OTS.

Cross sections for coherent and incoherent scattering of neutrons from polycrystalline materials are discussed. It is shown that the incoherent elastic, incoherent inelastic, and coherent elastic cross sections may be calculated with negligible error using a simple Debye model to give the phonon spectrum. The criterion for determining which Debye parameter to use is discussed, and it is emphasized that it is important to allow a temperature dependence in this parameter in order to take account of the temperature dependence of the phonon spectrum. The Debye model gave results which may be in error by about 15% at very low incident energies for the coherent inelastic cross section. (auth)

6746 THE HEAVY GAS MODEL IN DETERMINATION OF DIFFUSION COOLING COEFFICIENTS. Jouko Virkkunen (Inst. of Tech., Helsinki). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 51, 1-14(1960). (In English)

The heavy gas model for calculating neutron thermalization near thermal energies in which the effects of chemical bonds are neglected and the thermal motion of the moderator atoms is approximated, is applied to the energy-dependent neutron flux in a pulsed neutron experiment. The diffusion cooling coefficient C in the equation for the decay constant of the fundamental space mode, $\lambda = \lambda_a + DB^2 + CB^4$, is calculated for graphite, beryllium, and heavy water. The agreement with measured values is good for graphite and beryllium and can be improved for heavy water by adjusting the parameters. (D.L.C.)

6747 ON THE RATE OF CONVERGENCE OF THE SPHERICAL HARMONICS METHOD FOR THE PLANE CASE, ISOTROPIC SCATTERING. B. Davison (Univ. of Toronto). Can. J. Phys. 38, 1526-45(1960) Nov.

The rate of convergence of the spherical harmonics method in neutron transport theory, for the plane case with isotropic scattering, is investigated, for an arbitrary number of layers of different materials, and both in the one-group and in the multi-group theory. The attention is centered upon the cases when there is no external supply of neutrons, so that one deals with an eigenvalue problem. The error in the eigenvalue due to the truncation of the spherical harmonics expansion is found to vary essentially as $0(1/N^2)$, where N is the order of the highest harmonics retained. The proof of this result consists of two parts. Firstly it is shown that the use of the spherical harmonics method, under the conditions stated, is strictly equivalent to making a certain approximation in the kernel of the integral equation for the flux; and then the error due to this approximation is assessed. (auth)

6748 A NUMERICAL STUDY OF THE FAST NEUTRON SPECTRUM IN HOMOGENEOUS MEDIA. G. Rowlands (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. A. Reactor Sci. 13, 14-24(1960) Oct. (AERE-R-3160)

A purely numerical method for the study of the slowing down of fast neutrons produced uniformly in an infinite homogeneous medium was developed. Recurrence relations from which the slowing down density as a function of energy may be obtained by a simple step-to-step process are given. The slowing down density as a function of energy appropriate to light and heavy water and carbon moderators is discussed. The effect of inelastic scattering and anisotropic elastic scattering is considered and numerical values appropriate to carbon are given. Finite size effects are considered by introducing a fictitious absorption cross-section proportional to the geometric buckling. (auth)

6749 FLUX ADJOINTS FOR SLOWING DOWN PROBLEM IN INFINITE MEDIA. G. Rowlands (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. A. Reactor Sci. 13, 36-7(1960) Oct.

The application of the variational principle to a study of the slowing down of neutrons produced uniformly with a fission spectra in an infinite homogeneous medium is discussed. A trial function for the neutron flux adjoint was developed. (M.C.G.)

Nuclear Properties and Reactions

6750 (AFOSR-TN-60-1137) SPECTRA OF ODD-ODD NUCLEI. Technical Note No. 24. A. deShalit and J. D. Walecka (Stanford Univ., Calif. Inst. of Theoretical Physics.). Aug. 1960. 40p. Contract AF49(638)-388.

A general discussion of the spectra of odd-odd nuclei is presented. For this purpose it was found useful to develop a new method for the calculation of energy levels. An explicit expression is derived for the distribution of the relative angle of the two particles, properly weighted according to the spin-dependence of the interaction. With the help of these expressions the general structure of spectra of odd-odd nuclei can be more clearly seen. In particular the modified Nordheim rules are seen to hold quite generally, and it is found that for configurations containing a half-filled shell the lowest state has an even or odd J according to whether its parity is odd or even. (auth)

6751 (ANL-6235(p.1-10)) DECAY OF Tm^{172}. S. B. Burson and R. G. Helmer (Argonne National Lab., Ill.).

Eighteen γ rays from Tm^{172}, produced by double neutron

capture in Er^{170}, were measured and fitted into a decay scheme. Spin assignments are indicated for some levels. (auth)

6752 (ANL-6235(p.15-19)) BRANCHING RATIO OF α AND β EMISSION FROM Bi^{212} (ThC). S. Barkan (Argonne National Lab., Ill.).

The branching ratio of α and β rays from Bi^{212} was determined to within 1/3%. A correction was made for the Po^{212} tail. (auth)

6753 (ANL-6235(p.20-32)) 7.7-METER BENT-CRYSTAL SPECTROMETER. Robert K. Smither (Argonne National Lab., Ill.).

The spectra of capture γ rays below 2 Mev for $Cd^{113}(n,\gamma)Cd^{114}$ were measured with the 7.7-m bent-crystal spectrometer. These measurements were combined with a series of coincidence experiments to correct and extend the level scheme of Cd^{114}. (auth)

6754 (ANL-6235(p.33-51)) NEUTRON TOTAL CROSS SECTIONS IN THE Kev REGION. Carl T. Hibdon (Argonne National Lab., Ill.).

A study of the resonance levels of Na^{24} up to 860 kev revealed 230 levels, very few of which are s-wave levels. The distributions of the resonance parameters are given and compared with predictions of nuclear theory. Most of the levels of F^{20} up to 280 kev were studied by self-detection. (auth)

6755 (ANL-6235(p.62-5)) RELATIONSHIPS OF COLLECTIVE EFFECTS AND THE SHELL MODEL. D. Kurath and R. D. Lawson (Argonne National Lab., Ill.).

The strength of coupling between the positive-parity nucleon and the C^{12} core was investigated. Strong coupling, as implied by using the Nilsson model to generate wave functions, contradicts experiment. A reasonable picture arises from weak coupling with a strength consistent with that derivable from summing the two-body interaction integrals between the positive-parity nucleon and the core. (auth)

6756 (ANL-6247) THE FISSION ENERGETICS OF Th^{232}. A. B. Smith, R. G. Nobles, and A. M. Friedman (Argonne National Lab., Ill.). Nov. 1960. 20p. Contract W-31-109-eng-38. OTS.

The distribution of the kinetic energy of fragments emitted as a result of the neutron-induced fission of Th^{232} has been determined. Incident neutron energies of 1475 ± 35 kev and 1600 ± 35 kev were used. The distributions determined at the two incident neutron energies are identical. The measured total average fragment kinetic energy was 155 ± 4.5 Mev. The most probable fragment mass ratio is 1.47 ± 0.05, and the average kinetic energies of the light and heavy fragments are 95 ± 2 and 60 ± 3 Mev, respectively. The experimental results were related to the known systematics of neutron-induced and spontaneous fission. The effect of collective nuclear rotations at the saddle point is discussed, with particular emphasis on fission from specific rotational bands. (auth)

6757 (ANL-6263) A TECHNIQUE FOR OBSERVATION OF THE NUCLEAR MAGNETIC RESONANCE OF SOME SHORT-LIVED NUCLIDES AND ITS APPLICATION TO THE MEASUREMENT OF THE NUCLEAR g-FACTOR OF Li^8 (thesis). Donald Connor (Argonne National Lab., Ill.). Nov. 1960. 100p. Contract W-31-109-eng-38. OTS.

Submitted to the University of Chicago.

A novel technique is described for the observation of the nuclear magnetic resonance of some short-lived nuclides; namely, those which may be produced by slow-neutron capture and which decay by β emission. Substantial nuclear polarization ($\geq$10%) is obtained by the use of polarized neutrons, permitting observation of the parity-violating anisotropy in the β emission as a relative measure of the polarization and hence of its change when (in addition to a strong static magnetic field) an r-f magnetic field is applied. The resonance depolarization curves thus obtained give the Larmor frequency and hence the nuclear g-factor directly. The g-factor of Li^8 was measured in this manner. It is found to be 0.8265 ± 0.0005 n.m./$\hbar$, a value agreeing with one calculated by Kurath from an intermediate-coupling model but significantly greater than predicted by either extreme j-j coupling (0.65) or LS coupling (0.49). Assuming the spin of Li^8 to be 2, the observed magnitude of the β-decay anisotropy indicates that the neutron capture occurs predominantly ($\geq$ 80%) via channel spin 2. (auth)

6758 (HW-64866(p.4-7)) SUBTHRESHOLD FISSION-U^{234}. R. H. Odegaarden (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The fission cross section of U^{234} was measured in the vicinity of the known total cross-section resonance at 5.20 ev. The DR crystal spectrometer was used. The foils, prepared on 5-mil platinum backings and deposited on 7.92-cm^2 circular deposits, were loaded into a multiple plate fission chamber to measure the fissions. The measured resolution and Doppler broadened fission cross section are shown. A graph of fission cross section vs. energy is given. (W.D.M.)

6759 (JINR-D-533) ON THE ELASTIC SCATTERING OF γ-RAYS BY NUCLEI. L. I. Lapidus and Kuang-chao Chou (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1960. 8p.

The energy dependence of the elastic cross section of γ rays by nuclei near the threshold of photonuclear reactions is studied with the help of the dispersion relation for forward scattering. The first maximum in the cross section is shown to be connected with the dispersion effects. Further experiments, which are necessary for a more detailed analysis, are discussed. (auth)

6760 (JINR-E-611) ON SHAPES OF ALLOWED BETA SPECTRA. B. Kuchowicz (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 13p.

Two tentative explanations are presented of the deviations in β spectra. Both are a first step of a more detailed analysis to be performed subsequently. One of these alternative explanations makes the deviations observed due to possible G-nonconserving interactions. The second is based on the hypothesis of an intermediary chiral boson. Both explanations need further support. (C.H.)

6761 (NP-9549) PHYSIQUE DU NEUTRON RAPPORT D'AVANCEMENT DU 15.4.1960 AU 15.7.1960. (Neutron Physics Progress Report for April 15, 1960 to July 15, 1960). (Brussels. Centre d'Étude de l'Énergie Nucleaíre). Sept. 15, 1960. 58p.

Neutron Spectrometry. Measurements for the absolute value of the fission cross section of U^{235} at 0.1 to 0.01 ev were completed and an analysis begun. Low-geometry counting of fission foils was compared with a mass-spectrometric method. A value for $\sigma_0\Gamma^2$ of 218 barns ev^2 was obtained from transmission measurements in the region of the 1.456 ev resonance of indium. Integral Cross Sections. Cross sections for fission neutrons were measured and found to be: $S^{32}(n,\gamma)P^{32}$ (68.6 mb), and $Al^{27}(n,\alpha)Na^{24}$

(0.75 mb). It is shown that from fission rates and Pu^{239} formation rates in a BR-1 fuel rod it is possible to obtain quantitative information on thermal and epithermal distribution of the flux. Cold Neutrons. The cryostat was installed and moderation efficiencies of 13 materials were compared. Nuclear Spectroscopy. Isomeric transitions in Ir^{192m} and Ir^{194m} were studied, and a series of unreported γ rays were found in the decay of Sb^{124m}. Further work was done on the linear polarization of capture γ in Co^{60}, S^{32}, Ti^{49} and on the angular correlation of capture γ in Zr^{92}, Hg^{200}, Fe^{57}, and Cu^{64}. (T.R.H.)

6762 (NP-9552) TRAVAUX DE SPECTROSCOPIE NUCLEAIRE UTILISANT DIRECTEMENT LES NEUTRONS DU REACTEUR BR-I. (Work on Nuclear Spectroscopy Using Neutrons Directly from the BR-1 Reactor). P. Fettweis and J. Vervier (Brussels. Centre d'Étude de l'Énergie Nucléaire). 1960. 18p.

Presented at "Agence Internationale de l'Energie Atomique Colloque sur la Recherche en Physique au Moyen des Neutrons Émis par les Piles, Vienne, 17-21 Octobre 1960."

The neutrons from the BR-1 reactor were used in investigations of nuclear isomers and γ capture. A fast pneumatic conveyer is described which allows samples to be exposed to a flux of 10^{12} neutrons/cm^2/sec at the center of the reactor for 1 sec or more. Some of the shorter half lives measured are: Na^{24m} ($T_{1/2}$ = 0.02 sec, E_γ = 472 kev), and Ga^{72} ($T_{1/2}$ = 0.04 sec, $E_\gamma \simeq$ 90 kev). Special attention has been given rare-earth isomers, notably Yb^{169m} ($T_{1/2}$ = 50 sec, E_γ = 24 kev), Yb^{175m} ($T_{1/2}$ = 0.067 ± 0.004 sec, E_γ = 455 kev), and Yb^{177m} ($T_{1/2}$ = 6.5 ± 0.05 sec, $E_{\gamma 1}$ = 104, $E_{\gamma 2}$ = 212 kev). Gamma cascades were studied by a classical fast-slow coincidence circuit and the Hoogenboom sum circuit. The circuit was tested by γ annihilation of Na^{22} and the known cascades of Co^{60}, Na^{22}, Na^{24}, Cl^{38}, Mn^{56}, and In^{116}. A 15-mm neutron beam is extracted from the reactor core and passed through a B_4C collimator to a target at 2.65 m from the reactor. The flux is about 7×10^7 neutrons/cm^2/sec. The capture γ's are detected by two NaI(Tl) crystals 2-in. square at 75 mm from the target. The following cascades were found in $Hg^{199}(n,\gamma)Hg^{200}$: 6.44 Mev – 1.59 Mev (8.55 ± 0.21), 5.44 Mev – 2.64 Mev (6.18 ± 0.18), and 4.82 Mev – 3.25 Mev (16.94 ± 0.29). The numbers in parentheses indicate relative intensities. Comparison with previous results shows that the first cascade is actually two nonresolved cascades: 6.44 – 1.59 Mev and 6.31 – 1.73 Mev. (T.R.H.)

6763 (NP-9691) ENERGY LEVELS IN ^{166}Er NUCLEUS. Report No. 163/OFJ. (Poziomy Energetyczne Jądra ^{166}Er). E. Bożek, H. Niewodniczański, S. Ogaza, S. Szymczyk, and Yu. V. Norseev (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1960. 18p.

The level scheme of Er^{166} has been investigated from the decay of Tm^{166} (7.7 h) in equilibrium with Yb^{166} (58 h). Gamma-gamma coincidence experiments were performed, and a new level scheme for Er^{166} is proposed with levels at 80, 264, 788, 862, 957, 1536, 2140, and 2354 kev with corresponding spin and parity assignments. (auth)

6764 (NP-9696) APPROXIMATE WAVE FUNCTIONS IN THE CALCULATION OF ELECTRON EXCITATION ACCOMPANYING THE BETA-DECAY OF He^6. Report No. 170/ChR. (Przyblizone Funkcje Falowe w Obliczaniu Pobudzenia Elektronowego Towarzyszacego Rozpadowi Beta He^6). W. Kołos (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Sept. 1960. 7p.

The probability of nonexcitation of atomic electrons in the β decay of He^6 was calculated using approximate wave functions. The results are significantly different from those obtained with wave functions which give more accurate values of the energy. (auth)

6765 (ORNL-2904) A COMPILATION OF INFORMATION ON GAMMA-RAY SPECTRA RESULTING FROM THERMAL-NEUTRON CAPTURE. E. Troubetzkoy and H. Goldstein (Nuclear Development Corp. of America, White Plains, N. Y.). Jan. 18, 1961. 78p. For Oak Ridge National Lab. Contract W-7405-eng-26. Subcontract No. 1216.

Thermal neutron capture γ-ray spectra are compiled for various nuclei that are useful for reactor shielding applications. The bulk of the data is taken from a Chalk River group and a group at the Institute of Atomic Energy of the Academy of Sciences, USSR. All the data are presented in tabular form for seven energy intervals from 0 to above 9 Mev. In addition, figures illustrating the appearance of the spectra are given, including continuous differential spectra for 50 nuclei and line spectra for 15 nuclei. The line spectra consist of vertical lines having heights proportional to intensities. 80 references. (auth)

6766 (ORNL-3016(p.81)) DETERMINATION OF THE THERMAL VALUE OF η OF U^{233} AND U^{235} BY DIRECT COMPARISON OF CRITICAL PARAMETERS OF AQUEOUS SOLUTIONS. R. Gwin and D. W. Magnuson (Oak Ridge National Lab., Tenn.).

An experimental determination of the thermal value of η of U^{233} and U^{235}, based on the direct comparison of the critical parameters of dilute aqueous solutions of the uranyl nitrates of U^{233} and U^{235}, was completed. The average thermal values of η obtained are 2.284 ± 0.015 for U^{233} and 2.074 ± 0.015 for U^{235}. The 2200-m/sec values are the same, since the g factor for η is unity in each case. (auth)

6767 (ORNL-3016(p.81)) MEASUREMENTS OF η OF U^{233} AND U^{235} BY A MANGANESE-BATH TECHNIQUE. R. L. Macklin, G. deSaussure, et al. (Oak Ridge National Lab., Tenn.).

The final results, including all corrections, of the manganese-bath measurements of η of U^{233} and U^{235} were obtained. The 2200-m/sec value of η were 2.296 ± 0.010 for U^{233} and 2.077 ± 0.010 for U^{235}. (auth)

6768 (ORNL-3016(p.82-95)) THE SPECTRUM OF PROMPT GAMMA RAYS FROM U^{235} FISSION. F. C. Maienschein and R. W. Peelle (Oak Ridge National Lab., Tenn.).

In the continuing analysis of the experiment to determine the spectrum of γ rays emitted promptly in the thermal-neutron-induced fission of U^{235}, all experimental work and the combination of data, together with the corrections for all count-rate-sensitive phenomena, was completed for all energy regions. The source-strength determinations required for spectrometer efficiency measurements were obtained either by absolute coincidence counting techniques or by use of a 4π high-pressure ionization chamber, and the pair spectrometer efficiency and response to monoenergetic γ rays were expressed in a response matrix. The response matrices for the Compton and single-crystal spectrometers, two steps that must precede the final solution for the γ-ray spectrum, have not yet been formulated. (auth)

6769 (ORNL-3016(p.96-110)) GAMMA-GAMMA COINCIDENCE STANDARDIZATION OF SOURCES, WITH APPLICATION TO THE $B^{11}(p,\gamma)C^{12}$ REACTION. R. W. Peelle and F. C. Maienschein (Oak Ridge National Lab., Tenn.).

Methods are described for determining the disintegration rate of γ ray sources by coincidence counting of cascade γ rays. The equation for the source strength is derived for a moderately complex radionuclide cascade decay scheme and also for the cascade from the $B^{11}(p,\gamma)C^{12}$ reaction. Methods are given for the evaluation of the small correction terms that arise in the formulation. Experimental techniques used for a series of such determinations are described, typical results are given, and the range of applicability of the techniques is discussed. (auth)

6770 (ORNL-3016(p.110-15)) GAMMA-RAY INTENSITY RATIOS IN THE DECAY OF 105-DAY Y^{88}. R. W. Peelle (Oak Ridge National Lab., Tenn.).

A scintillation pair spectrometer and a γ-γ coincidence counting apparatus were utilized to obtain the relative intensities of the 2.74-, 1.84-, and 0.90-Mev γ rays in the decay of Y^{88} to Sr^{88}. The relative intensity of the 2.74- and 1.84-Mev γ rays was found to be $(5.97 \pm 0.25) \times 10^{-3}$, using pulse-height spectra obtained with a scintillation pair spectrometer together with efficiencies measured with calibrated sources of Na^{24}(2.75 Mev) and Y^{88}. The relative intensity of the 1.8- and 0.90-Mev γ transitions was obtained by comparing γ-γ coincidence measurements on sources of Y^{88} and Sc^{46} in the same geometry. The intensity ratio $S_{1.8}/S_{0.90}$ was found to be 1.064 ± 0.008. (auth)

6771 (ORNL-3016(p.116-25)) DETERMINATION OF THE INTERNAL CONVERSION COEFFICIENT OF THE 279-kev GAMMA RAY IN Tl^{203} BY ABSOLUTE COINCIDENCE TECHNIQUES. R. W. Peelle (Oak Ridge National Lab.).

The total internal conversion coefficient of Tl^{203} for the 279-kev transition in the decay of Hg^{203} was measured using an apparently novel method, involving absolute coincidence counting, to determine separately the rates of emission of the 279-kev γ rays and the conversion electrons. This measurement was made possible by the encapsulation of the Hg^{203} source within a small plastic scintillator. The 100% efficiency of this arrangement for conversion electrons made possible an almost complete separation between pulse-height ranges corresponding to decay events involving or not involving internal conversion. The value obtained for the K-shell internal conversion rate divided by total γ emission rate was 0.164 ± 0.006, if literature values for the relative internal conversion rates in the various shells are accepted. (auth)

6772 (ORNL-3016(p.242-4)) NEUTRON YIELDS FROM (α,n) REACTIONS. F. S. Alsmiller and G. M. Estabrook (Oak Ridge National Lab., Tenn.).

Isotopes decaying by α emission and certain light-element impurities may frequently be present in uranium and plutonium materials in sufficient concentrations to give a substantial neutron yield from (α,n) reactions. Calculations of such yields were made. Since no experimental data could be found concerning the ranges or stopping cross sections of α particles in uranium or plutonium, cross sections were computed by an empirical formula, with the parameters determined by a least-squares fit of all available experimental data for $Z > 20$. (auth)

6773 (ORNL-3016(p.319-21)) A STATISTICAL MODEL FOR NUCLEAR LEVEL SPACINGS. L. Dresner and E. Inönü (Oak Ridge National Lab., Tenn.).

An analytical investigation of the effects of a slight generalization of Wigner's simple formula for the distribution of nuclear level spacings was made. An equation was derived for the spacing distribution in which the relationship between a given spacing and a preceding spacing is considered. Agreement with the distribution given by the Wigner formula is good, but attempts to compare the new distribution with experimental data were inconclusive. (auth)

6774 (ORNL-3016(p.321-5)) AN ANALYSIS OF INELASTIC SCATTERING IN U^{238} BELOW 1 Mev. L. Dresner (Oak Ridge National Lab., Tenn.).

A semiphenomenological calculation of the partial inelastic scattering cross sections for U^{238}, for bombardment energies from 150 to 1000 kev, was completed. The method employed was that of Hauser and Feshbach, improved in several important respects. The calculated values of the (n,γ) cross section show good agreement with published experimental results. (auth)

6775 (TID-11041) LOW ENERGY NUCLEAR PHYSICS. Third Annual Report for the Period February 1, 1960–July 31, 1960. Philip S. Jastram (Ohio State Univ. Research Foundation, Columbus). Aug. 10, 1960. 253p. Contract AT(11-1)-605. OTS.

A dissertation on the Sb^{124} β-γ angular correlation is presented. Reprints and preprints covering decay-scheme and nuclear systematics investigations completed and submitted for publication during the past year are included. (W.D.M.)

6776 (TID-11041(Paper 1)) BETA-GAMMA DIRECTIONAL CORRELATION STUDIES IN ANTIMONY-124 (thesis). Karl J. Casper (Ohio State Univ., Columbus). Paper 1 of LOW ENERGY NUCLEAR PHYSICS. Third Annual Report for the Period February 1, 1960–July 31, 1960. 153p.

The results of the measurement of β-γ directional correlation as a function of the β energy for the 3^-, 2^+, 0^+ cascade initiated by the 2.31-Mev electron decay of Sb^{124} are analyzed, and a set of values is obtained for the three independent matrix element ratios which yield a computed correlation in good agreement with the experimental energy dependence. Auxiliary studies are reported on the decay scheme of Sb^{124} to verify and determine the position of a 7-kev γ ray that has been reported. (W.D.M.)

6777 (TID-11041(Paper 5)) 3^+ LEVELS IN EVEN-EVEN NUCLEI. M. K. Ramaswamy (Ohio State Univ., Columbus). Paper 5 of LOW ENERGY NUCLEAR PHYSICS. Third Annual Report for the Period February 1, 1960–July 31, 1960. 6p.

The low-lying even-parity odd-spin states in even-even nuclei are almost invariably 3^+. A plot of 3^+ states as a function of mass number A is given. A summary of the properties of 3^+ levels away from the strongly deformed region and a plot of E_3/E_2 as a function of mass number are given. (W.D.M.)

6778 (TID-11041(Paper 9)) RADIOIODINE-125. William G. Myers and H. C. Vanderleeden ([Ohio State Univ., Columbus]). Paper 9 of LOW ENERGY NUCLEAR PHYSICS. Third Annual Report for the Period February 1, 1960–July 31, 1960. 30p.

Iodine-125 with a 60-day half life is next to the longest

lived among the 21 radioactive isotopes of iodine. Its specific activity of 644×10^6 disintegrations per second per microgram (17.4 c/mg) makes it suitable as a tracer in investigations of the metabolism of stable I^{127}. The discovery, decay scheme, half life, production, availability, cost, and detection of I^{125} are discussed. Absorption of I^{125} photons is considered and a comparison with I^{131} is made. (W.D.M.)

6779 (TID-11041(Paper 10)) DIRECTIONAL AND POLARIZATION CORRELATION STUDIES IN THE DECAY OF 5-HOUR Sb^{118}. M. K. Ramaswamy, W. L. Skeel, D. L. Hutchins, and P. S. Jastram (Ohio State Univ., Columbus). Paper 10 of LOW ENERGY NUCLEAR PHYSICS. Third Annual Report for the Period February 1, 1960–July 31, 1960. 22p.

Directional and polarization measurements were carried out on the γ rays accompanying the decay of Sb^{118}. Spin and parity assignments are made, and the level scheme is discussed in terms of various nuclear models. (W.D.M.)

6780 (TID-11041(Paper 11)) DECAY OF Ti^{45} AND V^{47}. M. K. Ramaswamy, W. L. Skeel, and P. S. Jastram (Ohio State Univ., Columbus). Paper 11 of LOW ENERGY NUCLEAR PHYSICS. Third Annual Report for the Period February 1, 1960–July 31, 1960. 16p.

Scintillation-counter studies of the decay of Ti^{45} and V^{47} were made. Spin and parity assignments, decay schemes, and energy levels are given. (W.D.M.)

6781 (TID-11287) ON THE DIVERGENCE OF THE GREEN'S FUNCTION SERIES FOR REARRANGEMENT COLLISIONS. Ronald Aaron, Ralph D. Amado, and Benjamin W. Lee (Pennsylvania. Univ., Philadelphia). 1960. 19p. OTS.

The convergence of the Born series for rearrangement collisions is investigated in a potential model. For a certain class of potentials it is shown that the iterated series for the full two particle Green's function, $(k_1' k_2' | G(E) | k_1 k_2)$, in terms of either the free particle Green's function, the initial state Green's function, or the final state Green's function diverges for some continuous range of the variables k_1, k_2, k_1' and k_2' independent of the energy, E, of the incident particle. It is suggested that the usual Born series, which is an integral over this Green's function series, therefore, also diverges for rearrangement collisions independent of the incident energy. (auth)

6782 (TID-11302) CORRECTIONS TO THE PERTURBATIVE TWO-PION-EXCHANGE NUCLEAR POTENTIAL (thesis). Malcolm C. Younger (Pennsylvania. Univ., Philadelphia). 1960. 105p. OTS.

The reliability of the static limit for evaluating the two-pion-exchange internucleon potential is investigated. The determination of the corrections to the static limit is based on the definition of the potential in terms of the scattering matrix. Therefore, the static limit under consideration is the potential of Brueckner and Watson, insofar as rescattering corrections are omitted. (W.D.M.)

6783 (UCOL-P-502) STUDY OF ION OPTICAL THEORY AND DESIGN FOR THE UNIVERSITY OF COLORADO. Report No. 200-57-R1. (Brobeck (William M.) and Associates, Boulder, Colo.). July 1960. 89p. For Colorado. Univ., Boulder. OTS.

A beam handling system study falling within the area of ion optical theory and design is described which has the following objectives: (1) to determine and to present in convenient form for application the needed first-order ion optical parameters of bending and analyzing magnets and arrays of quadrupole magnets suitable for use at the cyclotron; (2) to study the performance of combinations of such elements that will be needed to produce the various beams required and to determine the effects of varying their geometrical relations, field strengths, and gradients; (3) to use this information as a guide in determining particular values for these variables which will meet the specifications requested; and (4) to evaluate the second-order aberrations of the specified double dispersion system and to offer suggestions for controlling these aberrations. (W.D.M.)

6784 (AEC-tr-4208(p.29-33)) A STUDY OF β- AND γ-RADIATION FROM MESOTHORIUM PREPARATIONS OF VARIOUS AGES BY THE IONIZATION METHOD. G. V. Gorshkov and M. L. Orbeli. Translated from Trudy Radievogo Inst. im. V. G. Khlopina 6, 29-33(1957).

Until recently, the majority of medical radioactive preparations in the USSR consisted of ~63% mesothorium and 64% radium in terms of γ-equivalents. As the preparation ages, the mesothorium gradually decays; and there is an accumulation of radiothorium. It is well known that γ rays from mesothorium are not as hard as those from radium, whereas γ rays from radiothorium are harder than those from radium. The primary β rays from radioactive preparations are completely absorbed by filters when such preparations are used for medicinal purposes. However, secondary β particles are excited in the filters and their hardness and intensity are characteristic of primary γ rays. Therefore, secondary β particles from mesothorium preparations will prove to be different from β particles from radium preparations, and, moreover, the radiation will change qualitatively and quantitatively as the preparation ages. A study was made of the β particles from mesothorium preparations of various ages. (W.L.H.)

6785 (UCRL-Trans-446) THE ALPHA-DECAY OF NONSPHERICAL NUCLEI. L. I. Gol'din, G. M. Adel'son-Vel'skiĭ (Adel'son-Vel'skiy), A. P. Birzgal, A. D. Piliya, and K. A. Ter-Martirosyan. Translated by Richard B. Mudge from Zhur. Eksptl'. i Teoret. Fiz. 35, 184-202 (1958). 64p. (Includes original, 20p.). JCL or LC.

The system of equations for the radial functions describing the movement of the α particles emitted from nonspherical nuclei with an arbitrary spin was examined. Equations determining the boundary conditions for the radial functions on the surface of nuclei and the formulas expressing the probability of α decay through values of the radial functions on the nucleus and the shape of the nucleus were obtained. A simple approximation of a formula was obtained, defining the dependence of the probability of α decay on the moment l, carried off by the α particle and the energy of the levels of the daughter nucleus. For even nuclei (0 spin) an analysis was made of the various methods of approximate solution of the system of equations for the radial functions. It was shown that the terms coupling the equations cannot, when $l > 2$, be regarded as a perturbation. An exact numerical solution of the system of equations for an elliptical nucleus with consideration of all the multipole reactions was carried out on the condition that there is a constancy of the wave function on the surface of the nucleus. The effect of higher harmonics was evaluated in expanding the equation of the surface of the nucleus according to Legendre polynomials. The results of the calculation were compared with experimental results. (auth)

6786 THE MÖSSBAUER EFFECT. Harry Lustig (Univ. of Illinois, Urbana). Am. J. Phys. 29, 1-18(1961) Jan.

The recent discovery and several important applications of recoilless γ-ray fluorescence are reviewed. A self-contained introduction to this currently very lively field of research is given. The importance of the fluorescence technique and its limitations, before Mössbauer's discovery, are discussed. Mössbauer's pioneering experiments are briefly described and Lipkin's simple theoretical explanation of recoilless γ-ray emission is presented. From among the large number of recent experiments that make use of the Mössbauer effect, two groups were selected for discussion. The first is concerned with the discovery of nuclear and magnetic properties of Fe^{57}; the other with a test of the principle of equivalence in general relativity, by a measurement of the gravitational shift in the frequency of radiation. (auth)

6787 SPECTRA OF THE NEUTRONS EMITTED IN FISSION BY ^{235}U AT ANGLES OF 0, 45 AND 90° TO THE LINE OF FLIGHT OF THE FRAGMENTS. Yu. A. Vasil'ev, Yu. S. Zamyatnin, E. I. Sirotinin, and E. F. Fomushkin. Atomnaya Energ. 9, 449-54(1960) Dec. (In Russian)

Neutron spectra emitted at 0, 45, and 90° in U^{235} fission by 14.3 Mev neutrons were measured. The angular distribution was determined for fission neutrons: $N(0°):N(45°):N(90°) = (3.23 \pm 0.12):(1.75 \pm 0.07):1.00$. The experimental data are correlated with theoretical data calculated on an assumption of Maxwell distribution in the fragment system. (tr-auth)

6788 CROSS-SECTION OF THE $^6Li(n,\alpha)^3H$ REACTION AT 2.15 Mev. V. P. Perelygin and K. D. Tolstov. Atomnaya Energ. 9, 488-9(1960) Dec. (In Russian)

Total and differential cross sections of $Li^6(n,\alpha)H^3$ reactions for d-d neutrons of 2.15 Mev were determined. The differential cross section in the inertia system was plotted. The total cross section after corrections was (215 ± 30) mb. (R.V.J.)

6789 NEW TECHNIQUE FOR THE DIRECT INVESTIGATION OF FISSION EVENTS. J. J. Kelsch, O. F. Kammerer, and P. A. Buhl (Brookhaven National Lab., Upton, N. Y.). Brit. J. Appl. Phys. 11, 555(1960) Dec. (BNL-4904)

An electron microscopic method for studying individual fission events in U^{235} was developed which uses an uranium sandwich consisting of a 10-A U^{235} film between two 50-A aluminum films and which was prepared by evaporation on a NaCl cleavage face. This sandwich is sealed in an aluminum capsule, irradiated to a dose of 2.8×10^{15} neutrons/cm² (thermal), floated off the NaCl crystal on water, and mounted on copper grids for electron microscopic examination, which shows light tracks (100 A wide, 100 to 20,000 A long) on a darker aluminum matrix. The tracks are probably due to vaporization of aluminum atoms along the path of the fission fragments. Annealing or electron bombardment does not change the track appearance. Similar results were obtained for copper, platinum, and silver as the matrix. (D.L.C.)

6790 ON THE PRODUCTION OF Be^7 IN THE NRX REACTOR BY THE $B^{10}(p,\alpha)Be^7$, $Li^7(p,n)Be^7$, AND $Li^6(d,n)Be^7$ REACTIONS. J. C. Roy, M. Bresesti, and J. J. Hawton (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys. 38, 1428-35(1960) Nov. (AECL-1089).

Beryllium-7 was produced in the NRX reactor by the following reactions: $B^{10}(p,\alpha)Be^7$, $Li^7(p,n)Be^7$, and $Li^6(d,n)Be^7$. The Be^7 was identified by its half-life and γ-ray energy. The (p,α), (p,n), and (d,n) reactions were initiated by protons and deuterons produced by neutron-hydrogen atom collisions and by neutron–deuterium atom collisions from the irradiation of boric acid, lithium hydroxide, and lithium deuteroxide, respectively. The same three reactions were initiated by protons and deuterons produced by (n,p) and (n,d) reactions on boron, lithium, and target elements chemically combined with lithium. (auth)

6791 DECAY OF Au^{196m}. T. M. Kavanagh (McGill Univ., Montreal). Can. J. Phys. 38, 1436-40(1960) Nov.

The isomeric state in Au^{196} decays to the ground state with an initial M4 transition of energy 175.5 ± 0.5 kev, followed by 148.2 ± 0.5 kev and 188.8 ± 0.5 kev transitions in cascade; a transition of 85.0 ± 0.5 kev is probably also in cascade with these transitions. There is evidence of a weak 135.9 ± 0.5 kev transition converted in platinum, indicating a small electron capture branch in the decay. The half life of the isomeric state is 9.5 ± 0.3 hours. (auth)

6792 (α,n) CROSS SECTIONS FOR ^{48}Ti AND ^{51}V. Akira Iguchi (Toho Univ., Japan), Hiroshi Amano, and Shigeo Tanaka. J. Atomic Energy Soc. Japan 2, 682-4 (1960) Nov. (In English)

The excitation functions for the reactions $Ti^{48}(\alpha,n)Cr^{51}$ and $V^{51}(\alpha,n)Mn^{54}$ up to $E_\alpha = 31$ Mev were measured by the activation method using a stacked-foil technique. The cross sections at maximum yield in the (α,n) reactions for Ti^{48} and V^{51} are $6.8^{+1.4}_{-2.0} \times 10^{-25}$ and $5.6 \pm 1.1 \times 10^{-25}$ cm², respectively. The (α,n) reaction for V^{51} is economically attractive for the production of carrier-free Mn^{54}. (auth)

6793 NEW RADIOACTIVE ISOTOPES OF THE RARE EARTH ELEMENTS. F. D. S. Butement and P. Glentworth (Univ. of Liverpool). J. Inorg. & Nuclear Chem. 15, 205-9(1960) Oct. (In English)

Three new radioisotopes were made by spallation reactions in rare-earth targets: Lu^{167}, half life 54 min, Tm^{161}, 32 min, and Tm^{163}, 2.0 hr, all decaying by electron capture. A previously known ytterbium isotope of uncertain mass number was assigned to Yb^{164}, with a half life of 85 min. A new radioactive terbium isotope decaying by K electron capture with a half life greater than three years was tentatively assigned to Tb^{158}. (auth)

6794 THE URANIUM Z/URANIUM X_2 BRANCHING RATIO. J. H. Forrest, S. J. Lyle, G. R. Martin, and J. J. Maulden (Univ. of Durham, England). J. Inorg. & Nuclear Chem. 15, 210-14(1960) Oct. (In English)

The UZ/UX_2 branching ratio in the natural uranium decay series was measured using a 4π counting method in conjunction with Pa^{231} as tracer and found to be 0.18 ± 0.02%. (auth)

6795 PILE OSCILLATOR MEASUREMENTS OF HIGHLY IRRADIATED PLUTONIUM. W. A. Cooper and H. Rose (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. A. Reactor Sci. 13, 6-13(1960) Oct. (AERE-R-3008)

Samples of plutonium alloyed with aluminum were irradiated up to a maximum neutron dosage of 1.7 n/kb in the NRX reactor at Chalk River. At this irradiation over 80% of the original Pu^{239} was destroyed. The resultant changes in cross-section were measured with the pile oscillator in Gleep. The results are in agreement with theoretical predictions based upon present world nuclear data for plutonium isotopes as compiled by Westcott (1958).

This agreement gives added confidence in the ability to predict reactivity changes due to plutonium formation or destruction in power reactors. (auth)

6796 THERMAL NEUTRON CROSS-SECTION MEASUREMENTS ON ^{175}Lu AND ^{176}Lu. A. H. Baston, J. C. Lisle, and G. S. G. Tuckey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. A. Reactor Sci. 13, 35-6(1960) Oct.

Measurements were made of thermal neutron reactions with samples of natural lutetium oxide and oxide enriched in Lu^{175} in order to determine the total cross sections of Lu^{175} and Lu^{176} in the energy range from 0.012 to 1.0 ev. The neutron time-of-flight spectra were examined with a 100-channel analyzer. A Breit-Wigner curve was fitted to the 0.142 ev resonance in Lu^{176} after corrections were made for the Doppler width and the finite resolution of the spectrometer. (M.C.G.)

6797 THE CORRECTION OF RESONANCE PEAKS FOR EXPERIMENTAL RESOLUTION. R. O. Lane, N. F. Morehouse, Jr., and D. L. Phillips (Argonne National Lab., Ill.). Nuclear Instr. & Methods 9, 87-91(1960) Oct. (In English)

A technique is discussed for the determination of the true resonance shape from a measured resonance shape when the apparatus resolution shape is known, or, conversely, the determination of the resolution function if the true resonance shape is known. The problem is essentially that of the solution of an integral equation of the first kind and use is made of the relations among the Fourier coefficients to determine the unknown function. A successful application is made to the case of a resonance in the total neutron cross section of carbon where the widths of the resonance and resolution function are comparable. Some of the limitations of the technique are discussed. (auth)

6798 THE DECAY OF Pb^{212}. P. G. Roetling, W. P. Ganley, and G. S. Klaiber (Univ. of Buffalo). Nuclear Phys. 20, 347-59(1960) Nov. (2). (In English)

The γ rays of Bi^{212} following the β decay of 10-hour Pb^{212} were studied using γ response function analysis, coincidence spectroscopy and directional correlation techniques. The coincidence results agree in general with the level scheme proposed by Krisyouk et al. A 177 kev γ ray was found, showing that transition to be M1 rather than E0. The weak 415 kev γ radiation was observed for the first time, and intensities assigned to all γ radiations. Angular correlation experiments show the spins of the 415 kev and 300 kev levels to be 1 and 2, respectively, in disagreement with Krisyouk. (auth)

6799 NUCLEAR STRUCTURE STUDIES IN THE LEAD REGION WITH (d,t) REACTIONS. Bernard L. Cohen, Santos Mayo, and Robert E. Price (Univ. of Pittsburgh). Nuclear Phys. 20, 360-9(1960) Nov. (2). (In English)

Energy distributions of tritons from (d,t) reactions in the isotopes of lead, bismuth, and thallium were measured with ≈100 kev resolution. Evidence is given on the location of the missing $h_{9/2}$ state in Pb^{207}. As theoretically expected, the spectrum from Bi^{209}(d,t) is quantitatively similar to that from Pb^{208}(d,t) except that all levels are split into two or more components. The energies of the states excited by Pb^{207}(d,t) agree well with those predicted from the True and Ford calculation. The cross sections for exciting these agree reasonably well with calculations from the True and Ford wave functions; but several changes in the latter are suggested, including a reduction of the $(p_{1/2})^{-2}$ configuration in the ground state from 73 to about 55%. The long sought 0^+ state apparently occurs at 1.19 Mev. The spectra from Pb^{206}(d,t) and from Tl^{205}(d,t) show marked similarities to each other and a general similarity with the spectrum from Pb^{208}(d,t); it is shown that this is to be expected. In general, the shell model of nuclear structure with inverse, stripping reaction theory gives a satisfactory quantitative explanation of all the data. (auth)

6800 NUCLEAR STRUCTURE STUDIES IN THE LEAD REGION WITH (d,p) REACTIONS. Bernard L. Cohen, Robert E. Price, and Santos Mayo (Univ. of Pittsburgh). Nuclear Phys. 20, 370-81(1960) Nov. (2). (In English)

Energy distributions of protons from (d,p) reactions in the isotopes of lead and bismuth were measured with ≈100 kev resolution and angular distributions of several of the groups were studied. The angular distribution from Pb^{207}(d,p)Pb^{208}(g.s.) agrees very well with the distorted wave Born approximation calculation of Tobocman and with measured angular distributions of $l_n = 1$ transitions in Pb^{206}(d,p)Pb^{207}. The difference from a measured $l_n = 3$ transition is quite large. From studies of the excitation of the various single hole states of Pb^{207} in Pb^{206}(d,p)Pb^{207}, the wave function of the ground state of Pb^{206} is determined to be approximately $\Psi_{206} = \sqrt{0.56}(p_{1/2})^{-2} + \sqrt{0.25}(f_{5/2})^{-2} + \sqrt{0.12}(p_{3/2})^{-2} + \sqrt{0.04}(i_{13/2})^{-2} + \sqrt{0.03}(f_{7/2})^{-2}$, which has less $(p_{1/2})^{-2}$, and more $(f_{5/2})^{-2}$, $(i_{13/2})^{-2}$, and $(f_{7/2})^{-2}$ than the theoretical wave functions of True and Ford, and of Kearsley. A new low-lying nonhole state of Pb^{207} is found. Extensive efforts to understand the spectrum from Pb^{208}(d,p)Pb^{209} are reported. The relative intensities of the various peaks are very difficult to explain. (auth)

6801 A SEARCH FOR DOUBLE DIPOLE DE-EXCITATION IN C^{12}. G. J. McCallum, D. A. Bromley, and J. A. Kuehner (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Phys. 20, 382-94(1960) Nov. (2). (In English)

An experimental search for the simultaneous quanta which would result from double E1 electromagnetic de-excitation of the 4.43 Mev, 2^+ state in C^{12}, in competition with the normal E2 de-excitation, has yielded negative results. The 4.43 Mev state was populated via the resonant $N^{15}(p,\alpha)C^{12}$ reaction; competing proton capture reactions preclude the establishment of an experimental limit on the branching ratio Γ_{2E1}/Γ_{E2} of less than 1.7×10^{-4}. It is suggested that this limitation applies generally to reaction studies of this branching ratio. Recent theoretical studies of this process suggest that Γ_{2E1} vanishes in first order, consistent with the experimental observations. (auth)

6802 NEUTRON EVAPORATION SPECTRA FROM (p,n) REACTIONS. Richard L. Bramblett and T. W. Bonner (Rice Univ., Houston, Tex.). Nuclear Phys. 20, 395-407 (1960) Nov. (2). (In English)

A new type of neutron spectrometer was used to compare neutron spectra from (p,n) reactions in several medium weight nuclei with Weisskopf evaporation theory. The method is very sensitive to the shape of the spectrum from 0.1 to 2.0 Mev, and allows the determination of the exponent k and the parameter τ in the expression $E^k e^{-E/\tau}$ for the neutron spectrum. Measurements of the (p,n) spectra from targets of Sn^{120}, Co^{59}, In^{115}, Ag^{109}, Sb^{123}, Nb^{93}, Rh^{103}, Cd^{114}, and Sn^{122} were made with a proton bombarding energy of 5.30 Mev. The neutron spectra

agree well with that predicted by evaporation theory (k = 1) for all of the reactions studied except $Sn^{120}(p,n)$ and $Co^{59}(p,n)$. The values of τ obtained for the remaining seven target nuclei are respectively 0.53, 0.56, 0.51, 0.57, 0.59, 0.49, and 0.46 Mev, with an estimated absolute error of 0.02 Mev. For those nuclei for which the neutron spectra agree with theory the variation of the level density parameter with atomic weight is roughly $a \approx 0.094 A(Mev)^{-1}$. Angular distributions were obtained for four representative target nuclei. The angular distributions of neutrons from $Sn^{120}(p,n)$ and $In^{115}(p,n)$ were isotropic to within 5%, whereas those from $Nb^{93}(p,n)$ and $Co^{59}(p,n)$ were symmetric about 90° with dips at 90° of 5% for Nb^{93} and 7% for Co^{59}. The angular distributions, in conjunction with information about the neutron spectra at 0 and 135° show that the contribution of direct interaction to these (p,n) cross sections is less than 5%. (auth)

6803 ENERGY SPECTRUM OF THE PHOTONEUTRONS FROM GOLD. R. F. Askew and A. P. Batson (Univ. of Virginia, Charlottesville). Nuclear Phys. 20, 408-16(1960) Nov. (2). (In English)

The energy spectrum of the neutrons produced at 90° to a gold target bombarded with 55 Mev bremsstrahlung was measured. Nuclear emulsions were used to detect the photoneutrons. The spectrum shows two peaks. The large peak at 1.25 Mev can be interpreted as due to the statistical decay of the compound nucleus. The smaller peak at about 5.5 Mev is assumed to come from a "direct" transition, as described by the Wilkinson model. A new method is presented for the calculation of the corrections involved for those proton recoils which leave the emulsion. (auth)

6804 QUASI-FREE DIFFRACTION SCATTERING. Gerhard Jacob and Th. A. J. Maris (Universidade do Rio Grande do Sul, Pôrto Alegre, Brazil). Nuclear Phys. 20, 440-54(1960) Nov. (2). (In English)

It is shown that a certain type of noncoplanar quasi-free proton-proton scattering on heavy and medium nuclei is able to give direct and clear information on the structure of the target nucleus and the mechanism of the interaction. It is expected that the particles and orbital angular momenta of the occupied single particle states in the least bound shell, and for some cases in the stronger bound shells, can be determined. In addition the radial extension of the surface interaction zone and its distance from the center of the nucleus would follow immediately from the expected interference patterns. (auth)

6805 NUCLEAR SPECTROSCOPY WITH NON-LOCAL POTENTIALS. A. N. Mitra (Muslim Univ., Aligarh (U.P.), India) and S. P. Pandya. Nuclear Phys. 20, 455-63(1960) Nov. (2). (In English)

A nonlocal separable potential derived earlier was used to calculate the T = 0 energy levels of the shell model configuration $(d_{5/2})^2$. The results are satisfactory, and the advantages of such a realistic and well-behaved potential over the other potentials, local but invoking singularities, hard cores, etc., for calculating nuclear energy levels are pointed out. (auth)

6806 (n,α) AND (n,p) REACTIONS IN Na^{23}. L. Varga (Central Research Inst. of Physics, Budapest). Nuclear Phys. 20, 487-90(1960) Nov. (2). (In English)

From the decay curve of the radioactive nuclei produced in the (n,α) and (n,p) reactions occurring in a NaI(Tl) scintillation crystal irradiated by neutrons of 14 Mev energy the ratio $\sigma(n,\alpha)/\sigma(n,p)$ of the Na^{23} nucleus was computed and found to be 2.4 ± 10% as compared with 3.1 obtained from the evaporation theory. (auth)

6807 ROTATION-VIBRATION INTERACTION IN NON-AXIAL EVEN NUCLEI. A. S. Davydov and A. A. Chaban (Moscow State Univ.). Nuclear Phys. 20, 499-508 (1960) Nov. (2). (In English)

Collective excitations of even nuclei are investigated without dividing the excitations into rotational and vibrational. The conditions which enable one to distinguish between rotational and vibrational excitations are investigated. Correction terms are determined which consider the interaction between both types of excited states. Level energies are determined for nonspherical nuclei for which division of the excitations into rotational and vibrational ones is meaningless. (auth)

6808 NUCLEAR SPINS OF NEODYMIUM-147 AND PROMETHIUM-147. A. Cabezas, I. Lindgren, E. Lipworth, R. Marrus, and M. Rubinstein (Univ. of California, Berkeley). Nuclear Phys. 20, 509-12(1960) Nov. (2). (In English)

The nuclear spins of 11-d Nd^{147} and 2.6-y Pm^{147} were measured to be I = 5/2 and I = 7/2, respectively, by the atomic beam magnetic resonance method. The result for Nd^{147} confirms an earlier measurement made by paramagnetic resonance. The result for Pm^{147} is surprising in view of the fact that no β transition was observed between the ground states of these two isotopes. (auth)

6809 LONG WAVELENGTH CRYSTAL SPECTROMETER AND THE NEUTRON ABSORPTION CROSS SECTIONS OF GOLD AND BORON. F. T. Gould, T. I. Taylor, W. W. Havens, Jr., B. M. Rustad, and E. Melkonian (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng. 8, 453-66(1960) Dec. (BNL-4913)

The absorption cross sections of gold and boron were measured at long neutron wavelengths with a single crystal spectrometer. Mica along with microcrystalline filters of beryllium and BeO was used as a monochromator for wavelengths of 4 to 8.75 Å, and for longer wavelengths a mechanical monochromator was used to remove second and higher order neutrons. Neutron beams with negligible higher order contamination were obtained with a wavelength resolution $\Delta\lambda/\lambda$ of 0.018. The total cross section of gold for wavelengths from 5 to 11.5 Å is $\sigma_t = (54.56 \pm 0.09)\lambda - (0.46 \pm 0.67)$ barns. Evaluation of the thermal neutron (2200 m/sec) absorption cross sections gave (98.8 ± 0.3) barns for gold and (7.56 ± 6) barns for boron in glass plates for use as secondary standards. (auth)

6810 THE TEMPERATURE COEFFICIENT OF THE RESONANCE INTEGRAL FOR URANIUM METAL AND OXIDE. E. Hellstrand, P. Blomberg, and S. Hörner (AB Atomenergi, Stockholm). Nuclear Sci. and Eng. 8, 497-506 (1960) Dec.

The temperature coefficient of the resonance integral for uranium metal and oxide was measured over a wide temperature range for rods with different diameters. The activation method was used and the 106 kev γ ray following the N^{239} decay was measured with a pulse-height analyzer. The resonance integral was expressed as a linear function of $\sqrt{T}$. The following approximate relations were found. Metal: $RI = RI_0 [1 + 10^{-2} (0.51 + 0.5\ S/M) (\sqrt{T} - \sqrt{T_0})]$. Oxide: $RI = RI_0 [1 + 10^{-2} (0.58 + 0.5\ S/M) (\sqrt{T} - \sqrt{T_0})]$. The results were compared with calculated values published

elsewhere. The experimental values lie lower than most theoretical ones, but in several cases there is agreement within the common limits of error. (auth)

6811 CROSS SECTIONS OF VARIOUS MATERIALS IN THE GODIVA AND JEZEBEL CRITICAL ASSEMBLIES. Cleo C. Byers (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 608-14(1960) Dec.

Neutron activation (n,γ) cross sections of various isotopes were determined in the Los Alamos Godiva and Jezebel assemblies by a comparison activation method. Where these values represent total capture, they may be used in conjunction with effective absorption cross sections (σ_a) from reactivity contribution measurements to obtain the effect of energy degradation of the neutrons by inelastic scattering. (auth)

6812 NEUTRON-ACTIVATION SENSITIVITIES. Oswald U. Anders (Dow Chemical Co., Midland, Mich.). Nucleonics 18, No. 11, 178-9(1960) Nov.

Sensitivities attainable in short-irradiation neutron activation analysis are given for 70 elements. The data were obtained from corrected 100-point spectra, covering the energy range from 0 to 3 Mev by summing the peak channels for the most prominent peaks of each element. (M.C.G.)

6813 TABLE OF RADIOACTIVE NUCLIDES. John F. Stehn (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucleonics 18, No. 11, 186-95(1960) Nov.

All currently known radioactive nuclides (over 1250) are listed with their half lives, emissions, and decay energies. Beta and gamma energies are limited to four, plus a range, given in order of decreasing intensity. The radiations of decay products are included whenever the decay product is markedly shorter lived than its product. (M.C.G.)

6814 GAMMA EMITTERS BY HALF-LIFE AND ENERGY. Nucleonics 18, No. 11, 196-7(1960) Nov.

A table of γ emitters according to their half lives and energies is presented. Only isotopes with half lives greater than 1 min are included. Where an isotope can decay by emission of γ rays of different energies, the emitter is listed in energy groups corresponding to each γ. (M.C.G.)

6815 NUCLEAR DATA FOR REACTOR STUDIES. H. H. Baucom, Jr. (Atomics International, Canoga Park, Calif.). Nucleonics 18, No. 11, 198-200(1960) Nov.

Thermal neutron data tabulations are given for elements with atomic numbers 1 through 101 and for several compounds. Included in the data are atomic weight, density, cross sections, total and energy absorption mass attenuation coefficients for 3 Mev γ rays, resonance integral, diffusion length, diffusion coefficient, cosine of scattering angle, and average logarithmic energy decrement. (M.C.G.)

6816 FISSION-PRODUCT YIELDS FROM NEUTRON-INDUCED FISSION. Seymour Katcoff (Brookhaven National Lab., Upton, N. Y.). Nucleonics 18, No. 11, 201-8(1960) Nov.

Thermal-neutron fission yields from U^{233}, U^{235}, and Pu^{239}; fission-product yields from fission induced by fast and 14 Mev neutrons; and decay chains and yields from thermal neutron fission of U^{235} are given in tabular form. Graphs showing mass distribution of U^{235}, U^{238}, and Th^{232} fission products are also included. All the yields were corrected for known perturbations resulting from neutron capture by fission products. (M.C.G.)

6817 FACTORS FOR CONVERTING DECAY CONSTANTS. Grace M. Estabrook (Oak Ridge National Lab., Tenn.). Nucleonics 18, No. 11, 209(1960) Nov.

A set of factors that permit calculation of the decay constant in terms of any time unit is given from the half life of any radioisotope. (M.C.G.)

6818 USING ACCELERATOR NEUTRONS. E. Alfred Burrill (High Voltage Engineering Corp., Burlington, Mass.) and Malcolm H. MacGregor. Nucleonics 18, No. 12, 64-5; 68(1960) Dec.

The properties and applications of accelerators and nuclear reactions that yield neutrons are discussed. Among the most useful reactions are $Be^9(d,n)B^{10}$, $H^3(d,n)He^4$, $H^2(d,n)He^3$, $Li^7(p,n)Be^7$, and $H^3(p,n)He^3$. The electron beams from an accelerator produce x rays which in turn yield neutrons through electromagnetic interactions with nuclei. The most useful of these reactions are $Be^9(\gamma,n)Be^8$, $H^2(\gamma,n)H^1$, and $U^{nat}(\gamma,n)U$. Applications of accelerator-neutron sources in reactor engineering, nuclear-explosion simulation, neutron activation, and biological research are described. A table of neutron sources and their characteristics is included. (M.C.G.)

6819 NEW BRANCHING RATIO FOR Kr^{85}. Klaus W. Geiger (National Research Council, Ottawa), Janet S. Merritt, and John G. V. Taylor. Nucleonics 19, No. 1, 97-101(1961) Jan.

A redetermination was made of the branching ratio of Kr^{85}. The method consisted of measuring the absolute β and γ intensities from Kr^{85} decay processes. The γ line at 0.517 Mev was determined by comparison with the 0.511-Mev positron annihilation radiation from Na^{22} standards. Internal-gas proportional counting methods were used to determine the absolute β disintegration ratio of Kr^{85}, from which the β intensity was determined. The resulting branching ratio is $0.46 \pm 0.04\%$, which is lower and more precise than the previous value of $0.65 \pm 0.15\%$. The accuracy of the Kr^{85} assay is essentially determined by the uncertainty in the branching ratio; the remaining errors, such as counting statistics and differences in absorption within sample and container walls, can be kept much lower. (B.O.G.)

6820 THE FIELD THEORETIC DEFINITION OF THE NUCLEAR POTENTIAL. [PART] III. J. M. Charap and M. J. Tausner (Univ. of Chicago). Nuovo cimento (10) 18, 316-41(1960) Oct. 16. (In English)

The scattering of nucleons at energies below the meson production threshold is discussed; the amplitude is a sum of five terms, each proportional to a different spin invariant. A comparison in perturbation theory, between the field-theoretic amplitude and that from potential theory enables a conclusion to be made that a potential that will reproduce the field-theoretic amplitude through the two-meson exchange contribution exists. This potential is a sum of five terms and is "local" in the sense that for a suitable choice of the spin-dependent operators, their coefficients are energy-independent. The potential is derived apart from radiative and rescattering corrections; it is again observed that the static limit ($\mu/M \to 0$) is not well defined. The spectral functions for the potential are calculated. Rescattering corrections are discussed and, assuming simple analyticity properties for Feynman graphs, are shown not to destroy the locality of the potential. It is not yet possible to furnish a proof independent of perturbation theory that a potential exists, as was done for spinless particles, because the necessary dispersion rela-

tions have not been proved; it is not even known for which choice of spin invariants they might be expected to hold. Some clues as to this choice of "proper" spin invariants are afforded by the limitations imposed in order that the fourth-order potential be energy-independent. (auth)

6821 OPTICAL MODEL ANALYSIS OF NUCLEAR SCATTERING. B. Buck, R. N. Maddison, and P. E. Hodgson (Clarendon Lab., Oxford). Phil. Mag. (8) 5, 1181-91 (1960) Nov.

The mathematical methods used in a calculation of nuclear interactions by the optical model are described, and the most efficient way of programing the calculation for an electronic computer investigated. (auth)

6822 COULOMB ENERGIES OF CLOSED-SHELL NUCLEI FROM SHELL-MODEL WAVE FUNCTIONS. N. V. V. J. Swamy (Karnatak Univ., Dharwar, India), V. K. Kembhavi, and D. G. Galgali. Phys. Rev. 120, 2069-71 (1960) Dec. 15.

Using harmonic oscillator wave functions, the Slater integrals were evaluated and expressed in the form of summation formulas. The Coulomb energies of seven closed-shell nuclei are estimated using the integrals. These estimates are compared with those based on a statistical model and a trapezoidal model. The influence of exchange energy on the Coulomb radius of a nucleus is shown to be sensitive to the model used. Although the $Z^{1/3}$ variation of exchange energy appears to be a suitable characterization, present estimates require a larger multiplying constant in the usually accepted expression for the exchange energy. The direct and "net" energies, computed from the three models, show very good agreement. (auth)

6823 GAMMA RAYS FROM Ga^{65} DECAY AND HALF-LIFE OF THE 54-kev LEVEL OF Zn^{65}. L. S. August and J. F. Friichtenicht (Naval Research Lab., Washington, D. C.). Phys. Rev. 120, 2072-80(1960) Dec. 15.

The energies and intensities of the γ rays following the positron and electron capture decay of Ga^{65} were determined by scintillation spectrometry techniques. At least twenty γ rays de-excite proposed levels in Zn^{65} at the following energies (in kev): 53.95 ± 0.01, 115.13 ± 0.02, 206 ± 2, 773 ± 10(?), 863 ± 10, 1040 ± 15, 1310 ± 20, 1480 ± 20, 1970 ± 40, and ~2300. A consistent cascade scheme for Zn^{65} is presented which incorporates all of the observed γ transitions. The first excited state of Zn^{65} was found to be isomeric with a half life of 1.65 ± 0.05 μsec. (auth)

6824 NUCLEAR EXCITATION BY SCATTERING OF 40-Mev ELECTRONS. W. C. Barber, F. Berthold, G. Fricke, and F. E. Gudden (Stanford Univ., Calif.). Phys. Rev. 120, 2081-90(1960) Dec. 15.

The electron energy spectra resulting from the scattering of 40-Mev primary electrons were measured for study of nuclear excitations. Targets of Li^6, beryllium, carbon, and silicon were employed at scattering angles of 132 and 160°; lead was studied at a single angle of 160°. In addition to the elastic peaks, all spectra show peaks corresponding to excitation of the target nucleus into well-defined energy states. Peaks corresponding to known levels in Li^6 at 2.18 and 3.56 Mev, in Be^9 at 2.43 Mev, and in C^{12} at 15.1 Mev, were measured and analyzed by a virtual photon theory to give values of $(4^{+1}_{-1.5}) \times 10^{-4}$, 6.2 ± 0.6, 0.13 ± 0.03, and (40^{+8}_{-8}) ev for the values of their respective radiation widths to the ground states. Other well-defined peaks were observed at excitation energies of 16.9 Mev in beryllium, 11.6 Mev in silicon, and 4.2 Mev in lead. Broad peaks corresponding to the excitation of the giant resonance were observed in carbon, silicon, and lead, with maxima at 23, 20, and 15 Mev, respectively, and integrated cross sections of 75, 125, and 6500 Mev-mb, respectively. These cross sections are uncertain by a factor of approximately two because they depend on arbitrary methods used in subtracting the continuum of low-energy electrons and on arbitrary assumptions about nuclear form factors. (auth)

6825 PARAMETERS OF SOME LOW-ENERGY NEUTRON RESONANCES IN PLATINUM. John R. Waters (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev. 120, 2090-4(1960) Dec. 15.

Measurements of the elastic scattering of neutrons from thin platinum foils were made as a function of neutron energy using a time-of-flight technique. Scattering areas were obtained for the 11.9-, 19.6-, 68-, and 96-ev resonances. These were combined with a thick-sample transmission measurement and transmission data from other workers to give values for the parameters of the resonances. Level spins and partial widths were derived by a least squares method. (auth)

6826 ENDOTHERMIC DEUTERON STRIPPING REACTIONS. I. STRIPPING NEAR THRESHOLD. E. K. Warburton (Princeton Univ., N. J.), and L. F. Chase, Jr. Phys. Rev. 120, 2095-2102(1960) Dec. 15. (PUC-1960-12)

Wilkinson's explanation of the good agreement between theory and experiment for low-energy low-Q value (d,p) and (d,n) stripping reactions is restated from the point of view of the dispersion relations derivation of the Butler stripping formula. From this point of view, the kinematical conditions that should lead to the least distortion of the stripping pattern appear in a simple way. As a consequence of Wilkinson's arguments, it is proposed that the stripping mechanism should contribute significantly to endothermic (d,p) or (d,n) reactions near threshold. Some (d,n) threshold work is discussed, and it is concluded that this work gives some evidence that the stripping mechanism is important near threshold. The information on the reaction mechanism near threshold which can be obtained from γ-ray angular distribution measurements in (d,pγ) or (d,nγ) reactions is discussed and a general form for the angular distribution function for either plane-wave or distorted-wave stripping is developed. The $B^{11}(d,n)C^{12}$ (15.1-Mev level) reaction is considered, and it is concluded that the experimental evidence is consistent with this reaction proceeding via the stripping mechanism near threshold. (auth)

6827 ENDOTHERMIC DEUTERON STRIPPING REACTIONS. II. $C^{12}(d,p_3\gamma)C^{13}$ REACTION. L. F. Chase, Jr., R. G. Johnson, and E. K. Warburton (Lockheed Missiles and Space Research Lab., Palo Alto, Calif.). Phys. Rev. 120, 2103-8(1960) Dec. 15.

The total cross section of the $C^{12}(d,p_3)C^{13}$ reaction (Q = −1.13 Mev) to the third excited state of C^{13} at 3.85 Mev was measured for deuteron energies of 1.7 to 3.1 Mev. The cross section was obtained from the yield of the 170-kev γ ray corresponding to the electric-dipole transition between the $\frac{5}{2}^+$, C^{13} 3.85-Mev level and the $\frac{3}{2}^-$, C^{13} 3.68-Mev level. The angular distribution of the 170-kev γ ray relative to the deuteron beam was investigated for the same deuteron energy region by measuring yields at 0 and 90° to the beam. The measured anisotropy is compared to the predictions of plane-wave and distorted-wave stripping. The γ-ray anisotropy for deuteron energies of 1.7 to

2.4 Mev is in good agreement with the predictions of plane-wave stripping. Seven compound nucleus resonances corresponding to known N^{14} energy levels were observed at deuteron energies of 2.4 to 3.2 Mev. The Breit-Wigner single-level formula is used to extract resonance parameters for these levels. (auth)

6828 NUCLEAR ORIENTATION OF Tb^{160}. C. E. Johnson, J. F. Schooley, and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev. 120, 2108-13(1960) Dec. 15. (UCRL-9267)

Nuclear orientation of Tb^{160} in a single crystal of neodymium ethylsulfate was observed by the anisotropic intensity distribution of γ rays. The alignment arises from the coupling of the nuclear-magnetic and quadrupole moments with the crystal field. The spin of Tb^{160} is shown to be 3, and the spin of the 1360-kev level in Dy^{160} is 2. The nuclear moments of Tb^{160} are $|\mu| = 1.60 \pm 0.25$ nm and $Q = +1.9 \pm 0.5$ barns. (auth)

6829 ABSOLUTE (d,α)-REACTION CROSS SECTIONS OF ZIRCONIUM, MOLYBDENUM, TITANIUM, AND SULFUR. Oswald U. Anders and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Phys. Rev. 120, 2114-19(1960) Dec. 15.

Absolute cross sections for 7.8-Mev deuterons were measured for the following reactions: $Zr^{94}(d,\alpha)Y^{92}$*; $Zr^{92}(d,\alpha)Y^{90}$*; $Zr^{90}(d,\alpha)Y^{88}$*; $Mo^{97}(d,\alpha)Nb^{95}$*; $Mo^{97}(d,\alpha)Nb^{95m}$; $Mo^{98}(d,\alpha)Nb^{96}$; $Mo^{92}(d,\alpha)Nb^{90}$; $Ti^{46}(d,\alpha)Sc^{44}$; $Ti^{48}(d,\alpha)Sc^{46}$; and $S^{34}(d,\alpha)P^{32}$*. Excitation functions were determined for the reactions indicated with an asterisk. Beam intensity was determined with a Faraday cage coupled to a current integrator able to measure the current with less than 1% error. The reaction products from the thin targets were chemically purified by carrier-free separations. The absolute disintegration rates were determined by 4π β counting and coincidence γ counting. Carrier-free tracer techniques were used to establish the yields of chemical purification steps. (auth)

6830 EVAPORATION OF CHARGED PARTICLES FROM HIGHLY EXCITED COMPOUND NUCLEI. W. J. Knox, A. R. Quinton, and C. E. Anderson (Yale Univ., New Haven). Phys. Rev. 120, 2120-8(1960) Dec. 15.

Energy spectra and angular distributions of α particles and protons emitted in the bombardment of nickel targets with 160 Mev oxygen ions were measured. The initial compound nucleus is characterized approximately by Z = 36, A = 75, total excitation energy = 125 Mev, and rms angular momentum = 50$\hbar$. The energy distributions had the shapes of evaporation spectra although they were displaced by several Mev toward lower energies compared to calculated evaporation spectra. The angular distributions were approximately symmetric about 90° and sharply peaked in the forward and backward directions. At all energies there was some excess of particles in the forward direction and at high energies the distributions were predominantly forward peaked. Most of the particles were believed to be evaporated from compound nuclei with angular distributions determined by the high angular momenta of the emitting systems. The angular distributions could be fitted by a theory with a single adjustable parameter that was related to the variation of level density with angular momentum and the incoming and outgoing angular momenta. The total cross section for α-particle production was 2.6 ± 0.6 barns and for protons 4.0 ± 1.0 barns. These cross sections were larger than the estimated cross section for compound nucleus formation, indicating that several charged particles are evaporated per interaction. About half the collision cross section is believed to result in compound nucleus formation. (auth)

6831 NUCLEAR RESONANCE FLUORESCENCE IN Cu^{63}: LIFETIMES OF EXCITED STATES AND THE SLOWING DOWN OF RECOILS (3-100 ev) IN CONDENSED MEDIA. J. B. Cumming, A. Schwarzschild, A. W. Sunyar, and N. T. Porile (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 120, 2128-37(1960) Dec. 15. (BNL-4922)

Measurements of the lifetimes of the 669- and 963-kev states of Cu^{63} were made using the nuclear resonance fluorescence technique. Self-absorption experiments yielded mean lives of $(2.94 \pm 0.24) \times 10^{-13}$ sec for the spin ½ 669-kev level and $(7.2 \pm 1.8) \times 10^{-13}$ sec for the spin ⅝ 963-kev level. The resonance yields from sources inside copper metal and in water solution were measured. The reduction of the resonance yields due to slowing down of the recoils from the β^+ decay was calculated with the use of the model of Vineyard et al., for the solid and with an elastic collision model for the liquid environments. These calculations are in good agreement with the measured yields and result in a unique spin assignment to the 669-kev state. The effect of the scatterer temperature on the resonance yield was shown to be in agreement with the "effective temperature" predicted by the theory of Lamb. (auth)

6832 SECOND-DIFFERENCE ANALYSIS OF BREMSSTRAHLUNG YIELD CURVES. K. N. Geller (Univ. of Pennsylvania, Philadelphia). Phys. Rev. 120, 2147-9(1960) Dec. 15.

The second-difference weighting function of the bremsstrahlung spectrum obtained from an empirical isochromat at 15.1 Mev and corrected for thick-target effects is shown to behave like a Δ function of width approximately equal to the energy interval in analysis. This behavior greatly simplifies cross-section analysis of bremsstrahlung-induced activation curves when resonance phenomena are present. Application of the method to preliminary yield data for the (γ,n) reaction in nitrogen and oxygen gives good agreement with known level structure. (auth)

6833 EVIDENCE FOR THE STATISTICAL MODEL OBTAINED FROM (p,n) SPECTRA OF THE ODD-EVEN ELEMENTS V, Mn, Co, Nb, Rh, AND In. Richard D. Albert, John D. Anderson, and Calvin Wong (Univ. of California, Livermore). Phys. Rev. 120, 2149-54(1960) Dec. 15. (UCRL-6045-T)

Spectra of neutrons emitted from (p,n) reactions were measured for the essentially monoisotopic odd-even elements V, Mn, Co, Nb, Rh, and In. The 7- to 8-Mev protons used were obtained from the Livermore 90-in. cyclotron. Neutron energy distributions were determined using time-of-flight techniques. Experimental results indicate agreement with the compound statistical model of the nucleus. Relative level densities obtained in this manner were found to increase with atomic weight as theoretically expected. Assuming a level density of the form $\exp[2(a\epsilon)^{1/2}]$, a values were obtained which varied as a = A/13. (auth)

6834 NUCLEAR E1 PEAK ENERGIES. J. H. Carver and D. C. Peaslee (Australian National Univ., Canberra). Phys. Rev. 120, 2155-61(1960) Dec. 15.

The peak energies E_g of electric dipole giant resonances in photonuclear reactions considerably exceed the shell-model spacings E_s in the same nuclei: The discrepancy $\delta = (E_g - E_s)/E_s$ is of order unity, although the giant res-

onances are supposed to arise mainly from transitions of nucleons between successive shells. An attempt was made to understand δ by noting that $|E_g - E_h| \ll E_g$ and considering sum rule expressions for the harmonic energy E_h. These sum rule expressions are well known to yield $E_h = E_d + E_x$, where E_x is special to the E1 operator and the charge exchange component of nuclear forces. Theoretical and empirical arguments are adduced that $(E_g - E_s)$ comprise mainly E_x, plus two secondary corrections that happen practically to cancel. Comparison with experiment gives a constant $E_x \approx 8$ Mev and thence a satisfactory account of δ. Previous discussions of δ appear to have neglected E_x and hence failed to obtain even the right order of magnitude of δ for real nuclei. The use of a constant E_x also allows an improved fit to the curve of $\int \sigma dE$ as a function of A. It is pointed out that the value of E_x is comparable in significance with the average nuclear potential V: By virtue of the E1 excitation mode, E_x represents the difference of even-parity and odd-parity two-nucleon interactions, while V represents a sum of even and odd interactions. The effective mass for the model ground-state wave function is treated as a derived quantity and turns out to be $M^*/M \gtrsim 1$; this large value is attributed to a Thomas shift associated with finite nuclear boundaries. (auth)

6835 REACTION $C^{12}(\alpha,d)N^{14}$. Bernard G. Harvey and Joseph Cerny (Univ. of California, Berkeley). Phys. Rev. 120, 2162-8(1960) Dec. 15. (UCRL-9259)

The energy spectra of deuterons from the reaction $C^{12}(\alpha,d)N^{14}$ were measured. The reaction was induced by 47.5-Mev helium ions. Angular distributions are given for the deuteron groups corresponding to formation of the ground state and 3.95-Mev level of N^{14}. Formation of the 2.31-Mev 0+, T = 1 level of N^{14} was not observed; the cross section was less than 3% of the cross section for formation of the 1+, T = 0 ground state. It is suggested that this cannot be interpreted as strong evidence for the conservation of isotopic spin for two reasons. First, several well-known T = 0 levels were not populated to an observable extent. Second, the reaction leading to the T = 1 level would involve a transition from a 0+ level to a 0+ level, and such transitions in (α,d) or (d,α) reactions involve difficulties with angular momentum and parity conservation in addition to nonconservation of isotopic spin, which requires $\Delta T = 0$. (auth)

6836 (He^4, Be^7) REACTION IN MAGNESIUM, ALUMINUM, TITANIUM, COBALT, AND COPPER FROM THRESHOLD TO 42 MEV. Richard H. Lindsay and Robert J. Carr (Washington State Univ., Pullman). Phys. Rev. 120, 2168-74(1960) Dec. 15.

Cross sections for the production of Be^7 in the helium ion bombardment of Mg, Al, Ti, Co, and Cu were measured in the 30- to 42-Mev energy range. The excitation functions for these reactions are presented. A study of the bulk (0 to 90°; 90 to 180°) laboratory angular distributions, by the catcher foil technique, of the Be^7 nuclei emerging from 2.0 and 1.85 mg/cm^2 magnesium targets and an examination of the approximate range-energy curves for the Be^7 particles in aluminum and magnesium indicated that the reaction proceeds through a compound nucleus. The experimental excitation function for the $Al^{27}(He^4,Be^7)Na^{24}$ reaction was compared with calculations based on the nuclear evaporation model. The cross sections for the production of Na^{24} and Be^7 in the helium-ion bombardment of aluminum are contrasted, and the difference between the yields leads to an excitation function for the (He^4,He^3He^4) reaction. (auth)

6837 PHOTONEUTRON DISINTEGRATION BELOW THE GIANT RESONANCE: BERYLLIUM-9 AND CARBON-13. N. C. Francis (Knolls Atomic Power Lab., Schenectady, N. Y.), D. T. Goldman, and E. Guth. Phys. Rev. 120, 2175-84(1960) Dec. 15.

The photoneutron cross sections of Be^9 and C^{13} were calculated. A single-particle model is used to describe the incident bound and final continuum distorted states. Using reasonable potential well parameters, the calculated $Be(\gamma,n)$ cross section near threshold was in agreement with experiment. Cross sections for transitions to both the $s_{1/2}$ and $d_{3/2}$ final states in C^{12} were calculated for γ-ray energies below 10 Mev. The calculated cross section was three times as large as the measured value at 6.4 Mev. The thermal neutron capture cross section in C^{12} was calculated and the error persisted in magnitude and sign. Origins of the inaccuracies in the model are discussed. Angular distribution and polarization formulas are presented. (auth)

6838 NUCLEAR STRUCTURE OF $_{50}Sn^{120}$. Hidetsugu Ikegami (Tokyo Univ.). Phys. Rev. 120, 2185-96(1960) Dec. 15.

The radiations from 5.8-day Sb^{120m} were investigated in detail, using sector type double-focusing magnetic spectrometers and scintillation counters. The following measurements were made: coincident γ-ray spectra, directional correlations of 1.18-Mev γ–1.03-Mev γ, 1.03-Mev γ–0.20-Mev γ, 1.18-Mev γ–0.20-Mev γ, 0.20-Mev γ–0.09-Mev γ, 0.20-Mev Ke^-–0.09-Mev γ and 0.20-Mev γ–0.09-Mev Ke^-. The 1.18-Mev γ–1.03-Mev γ polarization direction correlation, the conversion electron spectra, and the mean lives of the 2.41- and 2.50-Mev levels were also investigated. The decay scheme of 5.8-day Sb^{120m} proposed by McGinnis, which gives the following assignments to the excited states in Sn^{120}, 1.18 Mev(2+), 2.21 Mev(4+), 2.41 Mev(6+), and 2.50 Mev (7–), was confirmed uniquely. These levels were interpreted as arising from the neutron configurations $(2d_{5/2})^2(1h_{11/2})^2$ and $(2d_{5/2})^3(1h_{11/2})^1$. The lifetimes of the 2.41-, 1.18-, and probably 2.21-Mev levels are shorter by a factor 3 to 4 than those expected for single-proton transitions and may be explained by the neutron transition, assuming a somewhat larger effective charge of neutron in spherical and nuclei. The high forbiddenness of the 0.09-Mev E1 + M2 transition is ascribable to the simultaneous j- and l-forbidden transition between the states involving $(2d_{5/2})^3(1h_{11/2})^1$ and $(2d_{5/2})^2(1h_{11/2})^2$ configurations. No appreciable effects of the nuclear finite size or any nuclear structure dependence on the internal conversion process were detected even for the highly forbidden 0.09-Mev E1 + M2 transition. In the decay of 16-min Sb^{120}, the 1.18-Mev γ ray was detected. However, other γ rays expected from the second-level multiplet, which is a characteristic feature of the vibrational model, were not found. (auth)

6839 L/K-CAPTURE RATIO AND E_L/E_K FOR Ar^{37}. A. G. Santos-Ocampo and D. C. Conway (Purdue Univ., Lafayette, Ind.). Phys. Rev. 120, 2196-2200(1960) Dec. 15.

The L/K capture ratio of Ar^{37} was determined to be 0.103 ± 0.003 in a high-pressure multiwire proportional counter. This value is in excellent agreement with the theoretical value of 0.100. The average energy of the L peak was found to be 273 ± 6 ev. When a new value of 265 ± 5 ev is obtained for the critical L absorption energy

of chlorine by interpolation and the effect of the Auger process is considered, it is concluded that the energy to produce an ion pair in argon at 0.2 kev is 0.98 ± 0.04 times the value at 2.8 kev. (auth)

6840 REACTIONS $N^{14}(d,n)O^{15}$(g.s.) AND $N^{14}(d,n)O^{15*}$ (6.79 AND 6.86 MEV). A. J. Elwyn, J. V. Kane, S. Ofer, and R. Pixley (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 120, 2207-11(1960) Dec. 15.

The angular distribution of neutrons from the reaction $N^{14}(d,n)O^{15}$ (g.s.) was measured at 8 bombarding energies between 1.35 and 2.8 Mev. The same measurements were made on the neutron groups (unresolved) from the reactions $N^{14}(d,n)O^{15*}$ (6.79 Mev) and $N^{14}(d,n)O^{15*}$ (6.86 Mev) at bombarding energies of 2.55 and 2.7 Mev. Direct-interaction mechanisms are thought to be responsible for most of the observed yields althouth resonance-like effects were also seen. Neutron yields at forward angles showed approximate Butler stripping behavior at all energies in addition to other unexplained processes. The observed yields at large angles can be partially explained by the exchange stripping reaction for the high-Q reaction but can not be explained on this basis for the low-Q reaction. (auth)

6841 NUCLEAR ZEEMAN EFFECT IN Sn^{119}. S. S. Hanna, L. Meyer-Schützmeister, R. S. Preston, and D. H. Vincent (Argonne National Lab., Ill.). Phys. Rev. 120, 2211-13(1960) Dec. 15.

Ferromagnetic alloys of maganese and tin were used to obtain large internal magnetic fields at the tin nuclei. The resultant Zeeman splittings of the two low levels of Sn^{119} were measured by observing the hyperfine spectra in the resonant absorption of the 24-kev radiation of Sn^{119}. In Mn_4Sn an internal field of roughly 40 koe was found. In this field the splitting of the ground state was observed but that of the excited state was unresolved. In Mn_2Sn an internal field of about 190 koe was produced. In this field additional structure was obtained which was attributed to the splitting of the excited state. The measured splitting gave a value of (0.78 ± 0.08) nm for the magnetic moment of the excited state. (auth)

6842 SLOW NEUTRON RESONANCE SPECTROSCOPY. II. Ag, Au, Ta. J. S. Desjardins, J. L. Rosen, W. W. Havens, Jr., and J. Rainwater (Columbia Univ., New York). Phys. Rev. 120, 2214-26(1960) Dec. 15.

The results of time-of-flight measurements of silver, gold, and tantalum resonance parameters are presented. Neutron widths are given for 79 levels in silver to 728 ev, 55 levels in gold to 940 ev, and 62 levels in tantalum to 330 ev. Radiation widths for many of the stronger levels, and in some cases resonance J values were obtained. The reduced neutron width distributions are in good agreement with Porter-Thomas distributions for gold and tantalum. The distribution for silver shows a large excess of small $(2g\Gamma_n^0)$ values which are interpreted as p-wave resonances and correspond to a p-wave strength function $S_1 = (1.7 \pm 0.8) \times 10^{-4}$. The s-wave strength functions are $(0.51 \pm 0.09) \times 10^{-4}$ for silver, $(1.5 \pm 0.3) \times 10^{-4}$ for gold, and $(1.84 \pm 0.34) \times 10^{-4}$ for tantalum. The observation of p-wave silver levels is interpreted as due to a $p_{1/2}$ strength function resonance in this region. The level spacing distributions for gold and tantalum agree with the expected two-population Wigner spacing distribution function but not with random or single Wigner distributions. The weighted average $\Gamma\gamma$ values are 0.148 ev, 0.170 ev, and 0.060 ev for silver, gold, and tantalum, respectively. (auth)

6843 NUCLEAR MAGNETIC RESONANCE OF Xe^{129} IN NATURAL XENON. R. L. Streever and H. Y. Carr (Rutgers Univ., New Brunswick, N. J.). Phys. Rev. 121, 20-5 (1961) Jan. 1.

The spin-lattice relaxation time T_1 of Xe^{129} was measured as a function of temperature in the liquid and as a function of pressure in the gas. A strong shift ΔH in the external field required for resonance at constant frequency but varying sample density ρ was discovered. As the sample density increases in the region above 48 atm, ΔH decreases linearly at the rate of 3.45 milligauss per amagat (density at standard conditions) in a field of 8060 gauss. In the liquid the temperature dependence of the product of T_1 and ρ can be described by an activation energy of 0.7 ± 0.1 kcal/mole. In the gas at room temperature and 48 to 73 atm, T_1 varies as $\rho^{-2.1\pm0.4}$. The largest value of T_1 observed was 2600 ± 600 sec for a gas sample at 48 atm, and the shortest value was 57 ± 2 sec in liquid at −101°C. The experimental values of T_1 were compared with theoretical predictions in two limiting cases, the rare gas and the dense liquid. In both cases the experimental values, although larger than previously reported values, are still two to three orders of magnitude smaller than predicted from an intermolecular nuclear magnetic dipole interaction. The relaxation time was found to be independent of field. Implications of the data for determining the relaxation mechanism are discussed. It is suggested that the relaxation may be caused by a fluctuating magnetic field at the nucleus resulting from the motion of nonsymmetrical electronic charge distributions during collisions. (auth)

6844 TEMPERATURE DEPENDENCE OF THE NUCLEAR QUADRUPOLE SPECTRUM OF Nb^{93} IN FERROELECTRIC $KNbO_3$. Robert R. Hewitt (Univ. of California, Riverside). Phys. Rev. 121, 45-52(1961) Jan. 1.

The nuclear electric quadrupole interaction of Nb^{93} in ferroelectric $KNbO_3$ was measured as a function of temperature in the tetragonal, orthorhombic, and rhombohedral phases. The values of $(1/\nu)(d\nu/dT)$ for these three phases are approximately -10^{-3}, -10^{-3}, and -10^{-4} per degree centigrade, respectively. In the tetragonal phase at 220°C, e^2qQ/h was measured as 24 Mc/sec and the asymmetry parameter η is zero. An ionic calculation of field gradients in the tetragonal phase was made including point charge and induced dipole contributions. The results give the Sternheimer antishielding factor $(1-\gamma_\infty)$ as 15 in good agreement with its estimated value of +16. The temperature dependence of the electric field gradient at the Nb^{93} site as calculated from the ionic model is in agreement with the measured temperature dependence in the tetragonal phase. (auth)

6845 HYPERFINE STRUCTURE OF Fe^{57} IN PARAMAGNETIC AND ANTIFERROMAGNETIC FeF_2 FROM THE MÖSSBAUER EFFECT. G. K. Wertheim (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. 121, 63-6(1961) Jan. 1.

Measurements of the gamma resonant absorption in oriented slabs of FeF_2 were used to determine the magnitude and direction of the magnetic field at the iron nucleus in the antiferromagnetic state (3.40×10^5 oe at 0°K) and the quadrupole splitting in the paramagnetic state (31.2 Mc/sec) of this material. The observed electric and magnetic hfs in the antiferromagnetic state is interpretable in terms of an asymmetric electric field gradient tensor with its major axis perpendicular to the c axis, an asymmetry parameter of 0.33, and a quadrupole splitting of 30.3 Mc/sec at 45°K. (auth)

6846 NUCLEAR MAGNETIC RESONANCE OF Ni^{61} IN METALLIC NICKEL. L. J. Bruner, J. I. Budnick, and R. J. Blume (Columbia Univ., New York). Phys. Rev. 121, 83(1961) Jan. 1.

The nuclear magnetic resonance of Ni^{61} in unenriched metallic nickel was observed. The results provide the first experimental measure of the internal field at the nucleus in nickel. The resonance occurs at a frequency of 26.02 Mc/sec at room temperature, yielding an estimate of 170 kilogauss for the internal field. (auth)

6847 ISOTOPE EFFECT IN SUPERCONDUCTING LEAD. R. W. Shaw, D. E. Mapother, and D. C. Hopkins (Univ. of Illinois, Urbana). Phys. Rev. 121, 86-90(1961) Jan. 1.

A continuation is given of measurements of the difference in critical fields of superconducting lead specimens with various isotopic masses. The isotope samples were repurified and the low-temperature behavior is now more fully understood. The results near T_c are consistent with the relation $T_c = \text{const} \times M^p$, where M is the average isotopic mass, and yield a value $p = -0.478 \pm 0.014$. The measurements at lower temperatures confirm the similarity principle to within approximately 0.1% and indicate that γ, the coefficient in the normal electronic specific heat, is independent of isotopic mass to a similar accuracy. (auth)

6848 NUCLEAR MAGNETIC RESONANCE AND MAGNETIC ORDERING IN NiF_2. R. G. Shulman (Bell Telephone Labs., Murray Hill, N. J. and Univ. of Copenhagen). Phys Rev. 121, 125-43(1961) Jan. 1.

Measurements of the nuclear magnetic resonance of the F^{19} nucleus in single crystals of NiF_2 were made at 4.2 to 298°K. In the paramagnetic state at 298°K, for arbitrary directions of H_0 two resonances were observed, while for H_0 in a (100) plane only one resonance was observed as expected from the crystal symmetry. The shift of the resonances from the normal resonance field ω/γ_N allows one to calculate three independent parameters of the hyperfine interaction between the F^{19} nuclei and the magnetic electrons. In conjunction with measurements made in the antiferromagnetic state, it was possible to determine the individual components of the hyperfine interaction in units of 10^{-4} cm^{-1} as $A_s^I = 36.4 \pm 1.8$, $A_s^{II} = 42.1 \pm 2.1$, $A_\sigma^I = 9.1 \pm 0.9$, and $A_\sigma^{II} = 9.9 \pm 0.9$. Superscripts refer to the two different bonds with Ni^{2+} and subscripts s and σ refer to isotropic and anisotropic contributions. From these calculations were made for the fractions of unpaired spin in the corresponding fluoride ion s and p_σ orbitals are $f_s^I = (0.46 \pm 0.02)\%$, $f_s^{II} = (0.54 \pm 0.03)\%$, $f_\sigma^I = (4.1 \pm 0.4)\%$, and $f_\sigma^{II} = (4.5 \pm 0.4)\%$. Since geometrical considerations almost completely forbid magnetic p_π interactions in NiF_2, there is a negligible cancellation of p_σ interactions by the p_π so that, unlike the case for MnF_2 and FeF_2, the admixture of magnetic electrons into fluoride ion orbitals is almost completely determined. At temperatures just above the antiferromagnetic transition $T_N = 73.2$°K, the resonance shifts with H_0 in the (001) plane change rapidly with temperature. Between 75.7°K and T_N the susceptibility of one sublattice becomes negative while the other remains positive. This has been correlated with the sublattice susceptibility derived by Moriya from the spin Hamiltonian $\mathcal{H} = g\beta H + DS_z^2 + E(S_x^2 - S_y^2)$. By fitting the theoretical susceptibility the sign of E in this Hamiltonian has been determined. Below 73.2° the nuclear resonances are consistent with Moriya's model in which the spins are antiparallel along [100] and tipped ~1.3° toward [010]. Ericson's description of the magnetic ordering is shown to be incorrect. In the antiferromagnetic state the F^{19} resonance broadens as H_0 is lowered below 5000 gauss. (auth)

6849 POSSIBILITY OF A STRIPPING MECHANISM IN TRANSFORMATIONS INDUCED BY LITHIUM IONS. George C. Morrison (Univ. of Chicago). Phys. Rev. 121, 182-3 (1961) Jan. 1.

Angular distributions of the reaction $Li^7(Li^6,d)B^{11}$ leading to the ground state and first three excited states of B^{11} and the reaction $Li^6(Li^7,t)B^{10}$ leading to the ground state and first excited state of B^{10} were studied at an incident energy of 2.1 Mev. The principal features of the observed distributions are their asymmetry about 90° and slow variation of cross section with angle. The results suggest that the reactions proceed at least in part by a stripping mechanism with the capture of the alpha-particle core of the lithium projectile. The importance of this mechanism to the experimental investigation of the cluster model is indicated. (auth)

6850 EXCITATION FUNCTIONS FOR INELASTIC SCATTERING REACTIONS OF CADMIUM-111 AND INDIUM-115. Norbert T. Porile (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 121, 184-92(1961) Jan. 1. (BNL-4910)

Excitation functions were measured for the formation of Cd^{111m} and In^{115m} in the bombardment of Cd^{111} and In^{115}, respectively, with 6 to 10-Mev protons, 10 to 20-Mev deuterons, and 15 to 40-Mev alpha particles. The excitation function for the $In^{115}(\alpha,\alpha n)In^{114m}$ reaction was obtained. All the excitation functions increase monotonically with energy. The cross sections for the formation of In^{115m} at the highest bombarding energies are 1.5 mb, 42 mb, and 5.2 mb, for the proton-, deuteron-, and alpha-induced reactions, respectively. The corresponding cross sections for the formation of Cd^{111m} are 2 to 3 times larger. The results were compared with the predictions of the statistical theory. The only definite conclusion can be drawn in the case of the $(\alpha,\alpha\gamma)$ reaction where it is shown that an evaporation mechanism cannot account for the measured cross sections at bombarding energies above 25 Mev. The contribution of Coulomb excitation to the observed yields was calculated. It is found that this process contributes substantially to the $(\alpha,\alpha\gamma)$ and $(p,p\gamma)$ reactions, particularly at low bombarding energies. (auth)

6851 NUCLEON TRANSFER REACTIONS IN GRAZING COLLISIONS OF HEAVY IONS. Richard Kaufmann and Richard Wolfgang (Yale Univ., New Haven). Phys. Rev. 121, 192-205(1961) Jan. 1.

Reactions in which several nucleons are transferred between complex nuclei were studied by measurement of angular distributions and excitation functions of the recoiling projectile residues. The results show that multinucleon transfer does not proceed either through a compound nucleus or through a mechanism in which the Coulomb barrier is not penetrated (such as the tunneling mechanism for single-nucleon transfer). The data indicate the existence of a "grazing contact" mechanism. In such a grazing reaction, it appears that a high-energy projectile, though deflected by the Coulomb barrier, still penetrates the region of nuclear binding of the target. It moves along the surface of the target, with the zone of contact between the nuclei being frictionally excited and thus preventing formation of a compound nucleus. The system separates after half a rotation, or less, because the repulsive Coulombic and centrifugal forces exceed the nuclear binding force. Depending on the mode of separation, such grazing contact may result

in nucleon transfer, inelastic scattering, or breakup of the projectile. At energies well above the Coulomb barrier, such grazing processes appear to represent an important fraction of the geometric cross section. (auth)

6852 SINGLE-NUCLEON TRANSFER REACTIONS OF F^{19}, O^{16}, N^{14}, AND C^{12}. Richard Kaufmann and Richard Wolfgang (Yale Univ., New Haven). Phys. Rev. 121, 206-8(1961) Jan. 1.

Results on the angular distribution of single-neutron stripping products are presented. Beams of F^{19}, O^{16}, N^{14}, and C^{12} having an energy of 10 Mev per nucleon, and beams of O^{16} at lower energies were used in conjunction with a rhodium target. The relative contribution of tunneling and grazing transfer processes is discussed. The form of the angular distributions of products originating from the tunneling mechanism is very similar in all systems, although the magnitude of the F^{19} cross section is unexpectedly large. The cutoff distance for closest approach in a tunneling event is found to correspond to the cutoff for elastic scattering. (auth)

6853 COULOMB EXCITATION OF SECOND 2^+ STATES IN EVEN-EVEN MEDIUM WEIGHT NUCLEI. P. H. Stelson and F. K. McGowan (Oak Ridge National Lab., Tenn.). Phys. Rev. 121, 209-24(1961) Jan. 1.

The location of a second 2^+ state was found for thirteen even-even medium-weight nuclei by means of Coulomb excitation produced by 8-, 9-, and 10-Mev α particles. The relatively weak excitation of these states is detected by a coincident measurement of the cascade gamma rays. From the observed gamma-ray yields, information is obtained on the B(E2)'s for the crossover transitions. The crossover B(E2)'s exhibit some uniformity and are all rather weak, being about single-particle value or a little less. For some nuclei the cascades/crossovers ratio for the second 2^+ state is known from other work, and it is then possible to extract the B(E2) for the upper cascade transition. These upper cascade B(E2)'s exhibit enhancements comparable to those for the lower cascade transitions. Evidence is obtained for the "double E2" Coulomb excitation of the 4^+ state in Cd^{114} and this requires an enhanced $4 \rightarrow 2$ B(E2). In general, the measurements reported support a collective model interpretation, but it is as yet difficult to draw conclusions concerning the shape of the collective potential energy surface governing this motion. (auth)

6854 NUCLEAR SPINS OF THULIUM-166 AND 167. J. C. Walker and D. L. Harris (Princeton Univ., N. J.). Phys. Rev. 121, 224-7(1961) Jan. 1. (PUC-1960-17)

The spins of 7.7 hour thulium-166 and 9.6 day thulium-167 were measured by the atomic-beam magnetic resonance method. Spin values are Tm^{166}, I = 2; Tm^{167}, I = $\frac{1}{2}$. (auth)

6855 EXPERIMENTAL INVESTIGATION OF PARITY CONSERVATION IN THE 14.4-kev GAMMA TRANSITION IN Fe^{57}. Lee Grodzins and Frank Genovese (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. 121, 228-9(1961) Jan. 1.

An experiment using recoilless resonance scattering on the 14.4-kev M^1 gamma rays of Fe^{57} was performed to set a limit on the degree of parity impurities in the nuclear states involved. The anisotropies of the $\Delta m = \pm 1$ gamma-ray transition rates were examined toward and away from the direction of nuclear polarization. The use of recoilless resonance scattering allows the problem to be so overdetermined that instrumental anisotropies could be cancelled by appropriate summing of data. No parity-nonconserving anisotropy was observed. Taking into account the slowness of the M1 transition compared to a parity-admixed E1 transition of single-particle speed, a factor of 100 in amplitude, the limit on F, the relative strength of a parity-admixed wave function is, $F \leq 10^{-5}$. (auth)

6856 HIGH-ENERGY ALPHA PARTICLES AND TRITONS FROM THE SPONTANEOUS FISSION OF CALIFORNIUM-252. James C. Watson (Yale Univ., New Haven). Phys. Rev. 121, 230-1(1961) Jan. 1.

The energy spectra of alpha particles and tritons emitted in the spontaneous fission of Cf^{252} were measured using an E−dE/dx cesium iodide scintillator-proportional counter detector. The alpha-particle energy spectrum peaks at 16 Mev, with a full width at half maximum of about 15 Mev. The tritons peak at about 8 Mev, with a half-width of 7 Mev. One alpha particle is observed per 345 ± 20 fission events, one triton per 4500 ± 900 fission events. (auth)

6857 TRITIUM DECAY ENERGY. W. L. Pillinger, J. J. Hentges, and J. A. Blair (E. I. du Pont de Nemours & Co., Aiken, S. C.). Phys. Rev. 121, 232-3(1961) Jan. 1.

The heat output of tritium was determined calorimetrically as 0.3240 ± 0.0009 watt/gram. This value is about 1 to 4% higher than those previously reported. If the half-life of tritium is 12.43 ± 0.04 years, then its average beta energy is 5.73 ± 0.03 kev. (auth)

6858 LIFETIME OF THE FIRST EXCITED STATE OF N^{14}. C. P. Swann, V. K. Rasmussen, and F. R. Metzger (Bartol Research Foundation, Swarthmore, Penna.). Phys. Rev. 121, 242-5(1961) Jan. 1.

The mean life of the first excited state of N^{14} was measured by nuclear resonant scattering. The $N^{14}(p,p')$ reaction with an N^{14} enriched gaseous ammonia target was used as the source of Doppler-broadened γ radiation. The value of $(7.3 \pm 1.8) \times 10^{-14}$ sec obtained is a factor of two longer than theoretical predictions based on the wave functions used to explain the anomalously slow C^{14} β decay. (auth)

6859 DIFFERENTIAL CROSS SECTIONS OF THE $Be^9(Li^6,\alpha)B^{11}$ REACTION. J. J. Leigh and J. M. Blair (Univ. of Minnesota, Minneapolis). Phys. Rev. 121, 246-52 (1961) Jan. 1.

The differential cross sections of the $Be^9(Li^6,\alpha)B^{11}$ reaction were measured as a function of energy and angle. The α particles leaving the B^{11} in the ground state, α_0, in the first excited state, α_1, and in the second and third excited states, $\alpha_2 + \alpha_3$, were observed at 10° intervals from 10 to 160° (lab system) at Li^6 energies of 3.00, 3.25, and 3.50 Mev, and at 20, 60, 90, 120, and 160° (c.m. system) at Li^6 energies of 2.00, 2.50, 3.75, and 4.00 Mev. The angular distributions of the α_0 and α_1 groups are asymmetric about 90° c.m. Relative maxima occur at both large and small angles for each of the α-particle groups, with the yields at large angles being comparable to those at small angles. In all cases the angular distribution varies slowly with bombarding energy and the yields at each angle increase monotonically with increasing energy. At 3.50 Mev the total cross sections are 0.97 ± 0.38 mb for α_0 and 0.65 ± 0.26 mb for α_1. The experimental results suggest that the reactions proceed mainly by direct-interaction mechanisms. The similarity of the angular distributions of the $Be^9(Li^6,\alpha)B^{11}$ and the $Be^9(He^3,p)B^{11}$ reactions is pointed out. (auth)

6860 HALF-LIVES OF At^{211} AND Bi^{207}. E. H. Appelman (Univ. of California, Berkeley and Argonne National Lab., Ill.). Phys. Rev. 121, 253-5(1961) Jan. 1.

Least-squares analysis of alpha counting data yielded a half life of 7.214 ± 0.007 hr for At^{211}, in good agreement with previous results. From the gamma activity remaining after the decay of an extremely active At^{211} preparation, the half life of Bi^{207} was found to be 38 ± 3 yr. This agrees with the highest of the values hitherto reported. (auth)

6861 PROPERTIES OF FINITE NUCLEI. K. A. Brueckner (Univ. of California, La Jolla), A. M. Lockett, and M. Rotenberg. Phys. Rev. 121, 255-69(1961) Jan. 1.

The properties of O^{16}, Ca^{40}, and Zr^{90} were determined, using the Brueckner-Gammel-Weitzner theory of finite nuclei. Self-consistent solutions of the Hartree-Fock equations as modified by Brueckner and Goldman were obtained. The properties computed include binding energy, mean proton and neutron radii, separation energies, spin-orbit splittings, nonlocal and state-dependent single-particle potentials, surface depth of density and potentials, potential-density relation. The predictions of the theory are in semiquantitative agreement with experiment. (auth)

6862 TRIPARTITION IN THE SPONTANEOUS-FISSION DECAY OF Cf^{252}. M. Luis Muga, Harry R. Bowman, and Stanley G. Thompson (Univ. of California, Berkeley). Phys. Rev. 121, 270-4(1961) Jan. 1. (UCRL-9044)

The long-range alpha particles associated with the spontaneous-fission decay of Cf^{252} were studied by nuclear-emulsion techniques. The alpha-energy spectrum was found to peak at about 19 Mev with a half-width of 10 Mev, and the preferential angle of emission was found to be slightly less than 90° with respect to the light fission fragment. The results support the view that alpha emission occurs at the time of scission and that the direction is determined by the extent of electrostatic repulsion by the fragments. A trend toward a more nearly symmetric mass division in fission accompanied by alpha emission is indicated. The frequency of occurrence of the long-range alpha particles was observed to be 1 in 415 ± 10% binary fissions. Ternary events consisting of two heavy fragments and one light fragment of short range were observed, but the frequency with which these events occur was not measured. A parallel search was made for ternary-fission events in which fragmentation into comparable masses occurs. (auth)

6863 SCATTERING OF HIGH-ENERGY ELECTRONS FROM Ca^{40}, V^{51}, Co^{59}, In^{115}, $Sb^{121,123}$, AND Bi^{209}. H. Crannell, R. Helm, H. Kendall, J. Oeser, and M. Yearian (Stanford Univ., Calif.). Phys. Rev. 121, 283-9(1961) Jan. 1.

The absolute elastic electron-scattering cross sections of Ca^{40}, V^{51}, Co^{59}, In^{115}, $Sb^{121,123}$, and Bi^{209} were measured at a number of angles at a primary electron energy of 183 Mev. The cross sections were obtained by comparison with scattering from the proton. The data were compared with the previous relative angular distributions of Hahn, Ravenhall, and Hofstadter. The present data are in closer agreement with the charge distributions found from fitting a Fermi two-parameter model to the older data than with those found from a fit of the Ford and Hill charge distributions. The absolute cross sections for Bi^{209} show the least agreement: they are 35% larger than the predictions of the Fermi model and about 70% larger than the Ford and Hill model. (auth)

6864 PROTON MOTIONS IN AMMONIUM HALIDES BY SLOW NEUTRON CROSS-SECTION MEASUREMENTS. J. J. Rush, T. I. Taylor, and W. W. Havens, Jr. (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters 5, 507-9(1960) Dec. 1.

Total neutron cross sections were measured at room temperature for NH_3 gas at 115 psia, NH_4F, NH_4Cl, NH_4Br, and NH_4I, and the scattering cross sections per hydrogen atom plotted vs. neutron wavelength (λ_n). At short λ_n, the cross sections approach the values for the free atoms, while at long λ_n they may be represented by $\sigma_s = a + b\lambda_n$. The slopes b of the ammonium halides were determined from the graph and correlated with other properties of the halides, e.g., torsional frequency and potential barrier to rotation. The order-disorder transitions between phases I, II, and III of the halides are discussed. It is concluded that neutron cross section measurements can give evidence of the dynamics and chemical binding of hydrogen in molecules and crystals. (D.L.C.)

6865 ROTATING SELF-CONSISTENT FIELDS AND ROTATIONAL STATES OF NUCLEI. D. J. Thouless and J. G. Valatin (Univ. of Copenhagen). Phys. Rev. Letters 5, 509-10(1960) Dec. 1.

The self-consistent equations of the time-dependent Hartree-Fock method are shown to have solutions for rotating potentials. The resulting equation for the moment of inertia differs from that of the cranking model but is identical with that obtained by minimizing the ground state energy of the Hartree-Fock method with a prescribed expectation value of a total angular momentum component. (D.L.C.)

6866 EFFECT OF NUCLEAR ROTATION ON THE PAIRING CORRELATION. Ben R. Mottelson and J. G. Valatin (Univ. of Copenhagen). Phys. Rev. Letters 5, 511-12(1960) Dec. 1.

The effect of nuclear rotation on the pairing force in the low excited states of deformed nuclei was investigated by using the generalized Hartree-Fock method (used in superconductivity theory) to study the quantum mechanics of the effect for a reference system rotating with a rotational angular momentum I. For I greater than a critical value I_c, the pairing disappears and the particles perform an approximately independent motion in the average potential, resulting in an intrinsic structure orthogonal to the ground state and in rotational energies similar to those of a free Fermi gas. The I_c is estimated to be ~12 for A ~180 and ~18 for A ~238, which are only slightly higher than the highest rotational states reported for these nuclei. (D.L.C.)

6867 CLUSTER MODEL INTERPRETATION OF THE ISOTOPIC SPIN SELECTION RULE IN CERTAIN NUCLEAR REACTIONS. G. C. Morrison (Univ. of Chicago). Phys. Rev. Letters 5, 565-7(1960) Dec. 15.

The reactions $Li^6(Li^6,d)B^{10}$ and $Li^6(Li^7,t)B^{10}$ were studied at 2.1 and 2.2 Mev incident energy with particular reference to the T = 1, second excited state of B^{10} at 1.74 Mev. The deuteron and triton spectra for these reactions at a laboratory angle of 9.5 and 14.5°, respectively, show very low numbers of deuterons and tritons leading to the T = 1 level in B^{10}, whereas the isotopic spin selection rule precludes formation of the T = 1 level only in the $Li^6(Li^6,d)$ reaction. The reactions are explained by means of a stripping mechanism with capture of the alpha particle substructure in place of the isotopic selection rule. (D.L.C.)

6868 YIELD MEASUREMENTS OF ALPHA PARTICLES FROM THE $^{27}Al(p,\alpha)^{24}Mg$ AND $^{31}P(p,\alpha)^{28}Si$ REACTIONS. J. Kuperus and P. B. Smith (Fysisch Laboratorium der Rijksuniversiteit, Utrecht). Physica 26, 954-60(1960) Nov. (In English)

The yield of α particles from the $Al^{27}(p,\alpha)Mg^{24}$ and $P^{31}(p,\alpha)Si^{28}$ reactions was measured. Of the twelve known

$Al^{27}(p,\gamma)Si^{28}$ resonances in the E_p = 500 to 850-kev region, only those at E_p = 504,631, and 728 kev gave a detectable α-particle yield. Upper limits are given for the yields at the other resonance levels. Of the five $P^{31}(p,\gamma)S^{32}$ resonance levels in E_p = 400 to 850-kev region, only that at E_p = 641 kev showed detectable α-particle emission. (auth)

6869 SCINTILLATION SPECTROMETRY STUDY OF THE ^{73}Se ISOMERIC PAIR. R. A. Ricci (Instituut voor Kernphysisch Onderzoek, Amsterdam), R. Van Lieshout, and H. J. Van Den Bold. Physica 26, 1014-20(1960) Nov. (In English)

The positron and the γ-ray spectra of the two Se^{73} isomers were studied with a scintillation spectrometer. No new γ rays were observed in the decay of the (7.1 ± 0.2) hr activity. The (42 ± 3) min activity showed a positron group of (1.72 ± 0.10) Mev and three γ rays of 88, 251, and 580 kev, and possibly one of 1080 kev. The relative position of the two isomers could not be deduced from the results of these measurements; no isomeric transition was identified with certainty. If an isomeric transition occurs, it might be associated with the γ ray of 88 kev which then should be of M3 or E3 character, but this interpretation is not very attractive in view of shell model predictions for Se^{73}. (auth)

6870 AN INVESTIGATION OF SOME (^3He, d) REACTIONS IN LIGHT NUCLEI AT 5.2 Mev. P. D. Forsyth, F. de S. Barros, A. A. Jaffe, I. J. Taylor, and S. Ramavataram (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London) 75, 291-302(1960) Feb.

A broad range magnetic spectrograph was used to analyze the deuterons emitted from targets of B^{10}, B^{11}, N^{14}, and Al^{27} bombarded with 5.2 Mev singly ionized He^3 particles. The angular distributions of a number of the deuteron groups were measured, and an attempt was made to fit them with the predictions of stripping theory. The absolute differential cross sections were compared with those of the corresponding (d,n) reactions. The published differential cross sections for some (d,t) and (p,d) reactions were similarly compared. (auth)

6871 HIGH ENERGY SCATTERING OF NUCLEON FROM NUCLEI. A PROPOSED MODEL AND ITS EXPERIMENTAL VERIFICATION. Tatuya Sasakawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 241-58(1960) Aug. (In English)

A new model of high-energy scattering of nucleons from complex nuclei is presented. Under the assumption that the short-range correlation between nucleons and that the Pauli principle in the target nucleus in its ground state plays an essential role in the high-energy elastic scattering, the angular distribution of the high-energy elastic scattering from heavy nuclei can be predicted. It is characterized by the following important results: the positions of maxima and minima coincide respectively with those given by the impulse approximation; the absolute value of the angular distribution is obtained by multiplication of a constant factor $|\lambda|^2$ to that given by the impulse approximation; this factor is a constant independent of mass number and nearly independent of the incident energy in heavy nuclei; and, finally, the magnitude of $\sqrt{|\lambda|^2}$ is of order 0.4 ~ 0.5, which results from the Pauli principle in the target nucleus. In fact, analysis of the experimental data shows that the above expectation is valid. The scattering of 95-Mev protons is taken as an example. The factor $\sqrt{|\lambda|^2}$ is equal to 0.55 for copper and heavier nuclei to thorium in the case of meson theoretical phase shift ($\sqrt{|\lambda|^2} = 1$ for carbon, and 0.75 for aluminum). (auth)

6872 ON THE COLLECTIVE MOTION IN EVEN-EVEN SPHERICAL NUCLEI. Toshio Marumori (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 331-56(1960) Aug. (In English)

A method formally analogous to that developed by Bogoliubov, Tolmachev, and Shirkov to investigate the collective excitations in superconductors is applied to even-even spherical nuclei in order to investigate the mechanism of the nuclear collective motion from the standpoint of particle excitations. The theory leads, in principle, to the same results as those obtained by Belyaev. However, the method of description of the nuclear collective motion is quite different from that of Belyaev's paper in which the "cranking model" of Inglis is employed, and the various physical parameters used by Belyaev can be derived uniquely from the "first" principle. Thus, insofar as the vibrational motion is concerned, the physical implication underlying the nuclear collective model proposed by Bohr and Mottelson is made clear. (auth)

6873 COLLECTIVE EXCITATION OF NUCLEAR MATTER. Shigeaki Hatano (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 418-31(1960) Aug. (In English)

Collective excitations of nuclear matter that have their origin in the short-range interaction between nucleons in nucleus are studied in order to correlate strongly excited level groups in nuclear reactions of relatively high energy with nuclear structure. Making use of an effective internucleon potential that is determined from the analysis of pairing energies of various nuclei, the collective excitation energies are estimated in one particle-hole pair approximation of the new Tamm-Dancoff method. Three stable modes of excitations are possible; i.e., spin wave, isospin wave, and coupled spin-isospin wave. Of these three modes, the spin wave is the lowest exciting wave, the coupled spin-isospin wave is the second, and the isospin wave is the highest. Each of them has its own critical momentum above which they become unstable. The strengths of coupling of these exciting waves with particle motion are also estimated. The higher exciting wave has the stronger coupling with particle motion and therefore the larger width of excitation energy. These exciting mechanisms would have some connection with the experimental results on inelastic scattering of nucleons and photonuclear reactions. (auth)

6874 ON THE NON-AXIAL DEFORMATION OF THE MEDIUM AND HEAVY EVEN-EVEN NUCLEI. Jun Hiura (Hokkaido Univ., Sapporo) and Shōta Suekane. Progr. Theoret. Phys. (Kyoto) 24, 462-4(1960) Aug. (In English)

The asymmetry of the deformation of medium and heavy even-even nuclei with N ≥ 50 is calculated from their energy ratio of low-lying states on the basis of an asymmetric rotator model and is plotted on a γ_0 vs. N graph for more than 50 nuclei and for $0 \leq \gamma_0 \leq \pi/6$. From the graph, it is seen that, except for the nuclei of the near closed-shell regions, almost all nuclei with N ≥ 50 are grouped into $\gamma_0 \sim 26^0$ and $\gamma_0 \sim 10^0$, corresponding to the vibrational and rotational stages, respectively. The transitions between these two groups occur at N = 88 to 90, 110 to 116, and 136 to 138. The implications of these results are discussed. (D.L.C.)

6875 NUCLEAR FORCES AND THE FEW-NUCLEON PROBLEM. PROCEEDINGS OF THE INTERNATIONAL CONFERENCE, HELD AT THE PHYSICS DEPARTMENT,

UNIVERSITY COLLEGE, LONDON, ON JULY 8-11, 1959. VOLUMES I AND II. T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960. 723p. $30.00.

The eighty-three papers presented at the International Conference on Nuclear Forces and the Few-Nucleon Problem held at University College, London, on July 8 to 11, 1959 are included. Seventy four of the papers are covered by separate abstracts. Nine were previously abstracted in NSA. (M.C.G.)

6876 PHENOMENOLOGICAL ASPECTS OF THE TWO-NUCLEON INTERACTION. R. E. Marshak (Univ. of Rochester, N. Y.). p.5-21 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

The various phenomenological approaches to the two-nucleon interaction are distinguished and the relations among them discussed. Fundamental definitions and basic formulas are presented. The general formulation, experimental determination, phase-shift analysis, and breakdown of reflection and time reversal invariance are reviewed for the S-matrix approach. The successes and limitations of some of the calculations carried out with specific potential models are summarized. (M.C.G.)

6877 TWO-NUCLEON PHENOMENOLOGIC PHASE SHIFT VERSUS ENERGY FITS. G. Breit (Yale Univ., New Haven). p.23-38 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

A description of the two-nucleon interaction in terms of phase shifts is given. It was found that the quality of energy fits could be improved by employing one-pion-exchange phase shifts for the higher orbital angular momenta. One-pion-exchange was used in searches for p-p scattering through several energy ranges. A reformulation was made which localized one-pion effects and made them directly visual. (M.C.G.)

6878 ENERGY DEPENDENCE OF THE $^1S_0$ PHASE. H. P. Noyes (Univ. of California, Livermore). p.39-42 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

A modification of the phase shift analysis proposed by Moravcsik led to unique singlet S phase shifts at 1.397, 2.425, and 310 Mev. A calculation is presented which makes use of these three numbers to evaluate the three parameters that represent the characteristics of the nuclear force in the singlet S state. This calculation also allows the value of the singlet S phase to be predicted at all intermediate energies. (M.C.G.)

6879 NON-LOCALITY IN THE TWO-NUCLEON INTERACTION. C. Lee, J. L. Gammel, and R. Thaler (Los Alamos Scientific Lab., N. Mex.). p.43-4 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

Recent measurements of C_{nn} (90°) for p-p scattering at 320 and 360 Mev gave values more nearly in agreement with Solution 2 of Stapp et al. than with Solution 1. A non-local potential, required to fit Solution 2, was adjusted to determine whether experiments at energies other than 310 Mev will distinguish between local phenomenological potentials based on Solution 1 and nonlocal phenomenological potentials based on Solution 2. (M.C.G.)

6880 NUCLEON INTERACTIONS AS A BOUNDARY CONDITION. E. L. Lomon (McGill Univ., Montreal). p.83-91 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

The complications of nuclear potentials at small distances are reviewed. The pure boundary condition model fitted only those phase-shift sets characterized by a large negative $^3P_0$ phase shift and called Solution 6 of Stapp et al. Stapp Solution 1 was shown to be a good fit to the data when the G and high-angular momentum phase shifts were replaced by their one-meson exchange values. Several analyses that showed Solution 6 or Solution 1 phase shifts are discussed. The application of the boundary condition model to the many-body problem is also described. (M.C.G.)

6881 THE MESON THEORY OF NUCLEAR FORCES. K. A. Brueckner (Univ. of Pennsylvania, Philadelphia). p.109-21 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

The evolution of the present views on the meson theory of nuclear forces is reviewed. All methods agree on the second-order one-meson-exchange potential. This is only slightly affected by higher order terms for r greater than 1.6 $h/\mu c$. For distances less than this, the two-meson-exchange potential becomes important and predominates, except in the tensor potential. The effects of the long-range part of the meson potential was looked for in the deuteron quadrupole moment, proton-proton scattering at low-energy, and high angular momentum phase shifts in high-energy scattering. From experimental results it appeared that only the classical region, in which the low-energy behavior of meson coupling is involved, can be reliably predicted by meson theory. (M.C.G.)

6882 RECENT WORK DONE IN JAPAN ON THE TWO-NUCLEON INTERACTION. Junji Iwadare (Kyoto Univ.). p.123-42 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

An outline of the achievements of Japanese researchers on the verification of the pion theory of nuclear forces is presented. The Taketani theory is summarized. The characteristic features of the pion-theoretical potential are: the complicated shape of the potential, a strong negative tensor potential in the ^{3}0-state, the strong interaction in odd states in contrast to the Serber potential, and the absence of strong, direct spin-orbit coupling force in the outer region. The static pion-theoretical potential was found suitable for reproducing almost all existing two-nucleon data up to 150 Mev. Experiments verifying the pion-theoretical potential are reviewed. (M.C.G.)

6883 DISPERSION RELATION APPROACH TO THE NUCLEON-NUCLEON INTERACTION. Geoffrey F. Chew (Univ. of California, Berkeley). p.153-69 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

Applications of dispersion relations in descriptions of the nucleon-nucleon interaction are discussed. The two-dimensional spectra representation proposed by Mandelstam is considered. For the high angular momentum part of N-N scattering, where the phase shifts are small, it was found to be best not to separate individual angular momenta in the dispersion approach. The most effective method found for description of the low angular momentum part appeared to be that of considering energy dispersion relations for the individual partial wave amplitudes. The advantages of the dispersion relation approach and some results obtained with it are discussed. (M.C.G.)

6884 THE FIELD-THEORETIC DEFINITION OF THE NUCLEON-NUCLEON POTENTIAL. J. M. Charap and S. P. Fubini (European Organization for Nuclear Research, Geneva). p.175-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

It is shown that the static limit ($\mu/M \to 0$) leads to com-

pletely unreliable results in a perturbation theory definition of the potential, even in graphs without elastic scattering intermediate states. However, it is still possible to define a potential which is an energy independent function of r alone, which when inserted into a nonrelativistic Schrödinger equation reproduces the relativistic field-theoretic scattering matrix at sufficiently low energies. A method is developed whereby such a potential, in which both μ and M occur as parameters, is defined unambiguously for the case of a proton and a neutron scattering through a neutral field. By using dispersion relations for proton-neutron scattering, it is concluded that the potential reproduces the scattering matrix for momenta $\ll \sqrt{M\mu}$. Finally, a general method for explicit construction of the potential as a superposition of Yukawa potentials of different masses is proposed, and the one- and two-meson-exchange contributions to the potential are evaluated. (auth)

6885 THE IMPULSE APPROXIMATION AND SCATTERING FROM LIGHT NUCLEI. H. McManus (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.163-92 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

The Watson method for treating nucleon scattering from light nuclei is reviewed. A basic approximation in the method, the neglect of the antisymmetrization between the incident particle and the target nucleus, is emphasized. Several applications of the impulse approximation and the results obtained are discussed. In spite of the interference between isotopic singlet and triplet states, gross differences in the results from different two-nucleon input data were only obtained in those cases where the differences were already marked in the two-nucleon case. (M.C.G.)

6886 NUCLEON-HELIUM ELASTIC SCATTERING IN IMPULSE APPROXIMATION. L. S. Singh (Univ. of Birmingham, Eng.). p.203-6 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

The impulse approximation was used to calculate nucleon-alpha elastic scattering. The form factor dominated the shape of the differential cross section. The polarization of the scattered nucleon was also calculated. Graphs of the results are included. (M.C.G.)

6887 THREE-NUCLEON FORCES ACCORDING TO CHEW-LOW THEORY. R. T. Sharp and R. C. Smith (McGill Univ., Montreal). p.245-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

A static three-nucleon potential was derived. The effects of self-meson clouds and rescattering were included. To estimate the effect of the three-body force in nuclear matter, the two-body correlations due to the repulsive core were imposed. Preliminary estimates indicated that the contribution was about 3 Mev per nucleon, antibinding. (M.C.G.)

6888 PHOTONUCLEAR REACTIONS WITH LIGHT NUCLEI. D. Dixon (Glasgow Univ.). p.295-310 of "Nuclear Forces and the Few-Nucleon Problem. Volume I."

The interpretation of deuteron photodisintegration processes in terms of phenomenological nuclear potentials is described. Attempts to explain the magnitude of the isotropic component in the angular distributions are reviewed. Remarkable agreement with experimental results for angular distributions and total cross sections was obtained using repulsive core potentials with tensor and spin-orbit forces in triplet-odd parity states. Virtual meson effects were found to become important at energies above 100 Mev. The interaction of γ rays with α particles at energies below possible meson production was investigated. The five possible reactions that could take place are discussed. The angular distributions, predominantly proportional to $\sin^2\theta$, indicated electric dipole absorption. (M.C.G.)

6889 THEORETICAL ASPECTS OF THE THREE-BODY PROBLEM AT ENERGIES BELOW 50 MEV. H. S. W. Massey (Univ. Coll., London). p.345-55 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Four aspects of the nucleon three-body problem are considered: the binding energy of the triton and He^3, the differential and total cross sections for the elastic scattering of nucleons by deuterons, the polarization of nucleons scattered elastically by deuterons, and the cross sections for break-up of deuterons by nucleon impact. Several experiments involving these three-nucleon aspects are discussed. (M.C.G.)

6890 UPPER BOUNDS ON SCATTERING LENGTHS. Larry Spruch and Leonard Rosenberg (New York Univ., New York). p.375-83 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The zero angular momentum scattering of a spinless particle by a real, spherically symmetric, short-range potential was studied using a variational principle based on a minimum property for scattering theory. Various generalizations of the results are discussed. Neutron scattering by a compound system was also investigated. The variational method was limited to those systems for which only elastic scattering is possible and there can be no exothermic reactions. (M.C.G.)

6891 GROUND STATE ENERGY OF H^3, He^3 AND He^4. H. J. Mang, W. Wild, and F. Beck (Univ. of Heidelberg, Ger.). p.403-9 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The nuclear three- and four-body problems were studied in independent pair approximations. All the operators occurring in the problem acted only on space co-ordinates. All occupied one-particle states had the same space part wave function. The results for binding energy, root mean square radius for H^3 and He^4, and the Coulomb energy difference for H^3-He^3 are given. Tests were made of the internal consistency of the method. Results indicated that the independent pair model gives a reliable approach, at least for light nuclei. (M.C.G.)

6892 THE ELASTIC SCATTERING OF NUCLEONS BY He^4 NUCLEI. P. G. Burke (Univ. of London). p.413-33 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

Some recent work carried out on the elastic scattering of nucleons by He^4 below about 40 Mev is described. After developing the formulas which relate the differential cross section and polarization to the phase shifts, experimental measurements and associated phase-shift analyses are discussed. The resonance model interpretation of the data is presented, and finally the work on the relation of the "observed" phase shifts to the nucleon–He^4 interaction and the nucleon–nucleon interaction is reviewed. (auth)

6893 DOUBLET SPLITTING IN n-He^4 SCATTERING BY THE PION-THEORETICAL POTENTIAL. S. Nagata, T. Sasakawa, T. Sawada, and R. Tamagaki (Kyoto Univ.).

p.435-49 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The relation between the wide splitting of the doublet p phase shifts in low-energy neutron scattering by He^4 and the strong tensor force of the pion-theoretical potential was investigated. The main features and shape of the pion-theoretical potential are given. The method for deriving the spin-orbit term is discussed. The wide splitting of the p phase shifts in the low energy n-He^4 scattering can be explained by the strong tensor force of the one-pion-exchange potential in the triplet-even state. The strong tensor force also gives an important contribution to the binding energy of He^4. (M.C.G.)

6894 LOS ALAMOS EXPERIMENTS ON CHARGED PARTICLE REACTIONS INVOLVING LIGHT NUCLEI. Louis Rosen, R. C. Allen, A. H. Armstrong, J. E. Brolley, Jr., N. Jarmie, W. T. Leland, and L. Stewart (Los Alamos Scientific Lab., N. Mex.). p.481-96 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

An accumulation was made of data on the energy and angular dependence of the cross sections for attraction between hydrogen and helium isotopes at energies up to 8 Mev. Among the data discussed are: charge independence of nuclear forces, in particular the equivalence of n-n and p-p force; excited states of mass 3, 4, and 5 nuclei; existence of a stable di-neutron, di-proton, and H^4; and time-reversal invariance in strong interactions. Experiments by which the data were obtained are described. (M.C.G.)

6895 THE THEORY OF NEUTRON-TRITON SCATTERING. S. Hochberg (Imperial Coll. of Science and Tech., London), D. J. Newman, and H. H. Robertson. p.497-510 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The theory of neutron-triton scattering was developed using a nuclear interaction containing spin-orbit coupling and tensor forces as well as central exchange forces and wave functions of resonating group structure. The resulting integro-differential equations coupled the singlet and triplet states for spin-orbit forces and neighboring states of the same parity for tensor forces. The integro-differential equations for spin-orbit and central exchange forces were solved numerically on DEUCE, electronic digital computer at the National Physical Laboratory, Teddington. The derived total and differential scattering cross sections are found to agree with the most recent experimental results communicated by Dr. Seagrave of Los Alamos before publication. (auth)

6896 SCATTERING OF PROTONS BY He^3 AT 9.6, 8.6, 7.9, 6.8 AND 5.5 MEV. K. P. Artemov, S. P. Kalinin, and L. N. Samoilov (Lenin Inst. of Atomic Energy, Moscow). p.511-16 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Differential cross section curves were obtained for the elastic scattering of protons by He^3 at energies of 5.5, 6.8, 7.9, 8.6, and 9.6 Mev. Theoretical calculations using non-resonance phase shifts agreed satisfactorily with the p-He^3 scattering data, showing that there were no resonance effects in this energy region. The absence of resonance effects indicated that Li^4 has no clearly defined state possessing a lifetime appreciably in excess of the nuclear collision time. (M.C.G.)

6897 THE POLARIZATION OF THE NEUTRONS AND PROTONS FROM THE REACTIONS T(p,n)He^3 AND He^3(n,p)T. K. P. Artemov, N. A. Vlasov, and L. N. Samoilov (Lenin Inst. of Atomic Energy, Moscow). p.517-22 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 6915.

6898 THE INTERACTION OF NUCLEONS AND DEUTERONS WITH TRITONS AND He^3 AND RELATED REACTIONS. B. H. Bransden (The University, Glasgow). p.527-51 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Two-body reactions involving four or five nucleons were investigated at incident energies up to 20 Mev. The elastic scattering of protons by He^3 and neutrons by tritons was studied and the cross sections measured. The angular distributions above 1.5 Mev were characterized by a minimum which became progressively deeper and occurred at increasing angles as the energy was increased. The results for the proton collision were analyzed under the assumption that only S and P phase shifts were effective. The elastic scattering of neutrons by He^3 showed angular distributions similar to the p-He^3 and n-T interactions. The cross sections for the elastic scattering of protons by tritons exhibited a minimum near the threshold of the charge exchange reaction. Then the total cross section rose to a broad maximum at a proton energy of 3 Mev. The elastic scattering of deuterons by deuterons was studied at energies from 1 to 20 Mev. The angular distribution was symmetrical about 90°. The calculated cross sections were about three times larger than the observed values. The reactions surveyed all appeared to be capable of a "direct interaction" interpretation. (M.C.G.)

6899 REACTIONS INVOLVING SYSTEMS CONTAINING FOUR NUCLEONS. J. E. Young and W. M. Visscher (Los Alamos Scientific Lab., N. Mex.). p.553-4 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Theoretical investigations were made of some of the reactions between nucleons in the A = 4 complex in the energy range 1.5 to 14 Mev. Analysis was restricted to final states containing no more than three fragments. Some of the reactions studied are mentioned. (M.C.G.)

6900 THE ELASTIC SCATTERING OF He^3 BY He^3. B. H. Bransden and R. A. H. Hamilton (The University, Glasgow). p.555-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The formulation of the two-body scattering processes associated with six nucleons is considered. A central potential between nucleons, consistent with the binding energies of the deuteron and α particle, was used. The radial equations describing He^3-He^3 and T-T elastic scattering were integrated numerically to provide scattering phases for energies from 1 to 29 Mev. (M.C.G.)

6901 ELASTIC SCATTERING INVOLVING LIGHT NUCLEI. W. Laskar (Univ. Coll., London), C. Tate, and P. G. Burke. p.559-69 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The resonating group formalism was applied to four- and five-nucleon reaction processes. For the four-nucleon case, three groupings D-D, n-He^3, and p-T were taken, and for the five-nucleon case, two groupings D-T and n-He^4. The central potential used was of Gaussian shape with exchange dependence (Serber and symmetrical exchange were mainly investigated). The wave functions for the nuclear ground states were Gaussian (double Gaussian for the deu-

teron and single Gaussian for T, He^3, and He^4). The parameters were determined by variational methods to fit the binding energies. Coupled integro-differential equations were derived for each value of the total spin and angular momentum of the corresponding system. Preliminary results were obtained by including only one channel for D-D and D-T and are given. (auth)

6902 THE T(d,n)He^4 REACTION AS AN S-WAVE DETECTOR OF DEUTERON POLARIZATION AND 14 MEV POLARIZED NEUTRON SOURCE. H. B. Willard, A. Galonsky, and T. A. Welton (Oak Ridge National Lab., Tenn.). p.577-80 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The problem of finding a suitable nuclear reaction for analyzing the polarization of ions at voltages below a few hundred kev is discussed. Most reactions at these energies proceed by S-wave interaction. In both the scattering and reactions induced by polarized S-wave particles of spin $\frac{1}{2}$, the angular distribution is isotropic. T(d,n)He^4 and He^3(d,p)He^4 reactions can be used as polarization detectors. (M.C.G.)

6903 THE T(p,n)He^3 REACTION AND ITS INVERSE. J. D. Seagrave (Los Alamos Scientific Lab., N. Mex.). p.583-93 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The T(p,n)He^3 reaction was studied in order to determine the absolute forward yield and the relative angular distribution. The absolute forward yield measurements were made with counter telescopes at energies from 2 to 7.5 Mev. Using the results on the forward yield of the reaction, the energy sensitivity of a long counter was investigated. It was found that the sensitivity curve was neither flat nor smooth. A series of complete angular distributions was obtained at intervals of the proton energy range 1.5 to 5.5 Mev. The total cross section was measured. The inverse reaction is also discussed. (M.C.G.)

6904 THE SCATTERING OF He^3 PARTICLES BY PROTONS, DEUTERIUM, He^3 AND He^4. J. S. C. McKee (Univ. of Birmingham, Eng.). p.609-14 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The elastic scattering of He^3 particles by deuterons, He^3, He^4, and protons was investigated. Angular distributions were determined. Satisfactory statistics for inelastic processes were obtained only for the reactions $He^3 + He^4 \rightarrow Li^6 + p$ and $He^3 + He^4 \rightarrow Li^{6*} + p$. (M.C.G.)

6905 SCATTERING OF DEUTERONS FROM TRITIUM AND He^3 AT LOW ENERGIES. Yu. (I.) G. Balashko and I. Ya. (I.) Barit (Academy of Sciences, Moscow). p.615-18 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Triton and He^3 elastic scattering cross sections on deuterium were measured at an angle of 90° and at energies below 260 kev. The energy dependence of the measured differential elastic scattering cross section displayed peculiarities characteristic of resonance scattering. The one-level dispersion formula curve fit the cross section of all the processes studied. (M.C.G.)

6906 SCATTERING OF PROTONS FROM TRITIUM AT LOW ENERGIES. Yu. (I.) G. Balashko, I. Ya. (I.) Barit, and Yu. A. Goncharov (I. A. Gontcharow) (Academy of Sciences, Moscow). p.619-23 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 18569.

6907 CALCULATION OF BINDING ENERGIES OF NUCLEI IN THE NEIGHBOURHOOD OF 16 NUCLEONS USING THE BRUECKNER METHOD. V. J. Emery (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.627-34 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

A series of calculations is reviewed in which the Brueckner method is applied to light nuclei in order to calculate the nuclear properties described by the shell model and the two-body effects for which the model is unable to account. The binding energy of O^{16} was calculated. The disagreement of the calculation with experiment was sufficiently great to necessitate a study of the possible sources of error. (M.C.G.)

6908 HARTREE-FOCK METHOD FOR STRONGLY INTERACTING SYSTEMS. K. A. Brueckner (Univ. of Pennsylvania, Philadelphia), Andrew Sochett, and M. Rotenberg. p.635-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

In the study of nuclear matter, a good approximation of the total energy is given by the K-matrix approximation. Using Gammel–Thaler potentials adjusted to fit the deuteron, the equations were solved and gave values for nuclear density, energy, and symmetry energy in good agreement with empirical values. To apply these methods to finite nuclei, an assumption was made that the local correlation structure of a finite nucleus is the same as nuclear matter at the same local density. The results gave the correct density and surface structure for O^{16}, but too small a value for binding energy. (M.C.G.)

6909 BINDING ENERGY OF Be^8 AND C^{12} AND α-α SCATTERING. S. J. Biel, A. C. Butcher, and J. M. McNamee (Univ. Coll., London). p.641-6 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The binding energies of Be^8 and C^{12} were calculated using an α-particle model, but employing correctly symmetrized wave functions. Solutions were also obtained for the equation representing the relative motion of the two α-particle centers in Be^8, which could be interpreted as corresponding to α-α scattering. Agreement between experimental results and those calculated using Biel's combination (70% Serber force, 30% MHWB force) was found to be remarkably good. (M.C.G.)

6910 THREE-BODY MODEL OF Li^6. P. H. Wackman and N. Austern (Univ. of Pittsburgh). p.649-52 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

An attempt was made to test the three-body model by using it as a basis for computing the properties of Li^6. A variational wave function was constructed and inserted in Rayleigh's principle. This principle was employed independently for each of the first four levels of Li^6 and the level scheme found. A test of the model was made by computing the probability for both orbital nucleons to be within the α particle simultaneously. This was found to be 3.7%. (M.C.G.)

6911 PROPERTIES OF C^{12} AND THE EFFECTIVE TWO-NUCLEON CENTRAL INTERACTION. Sydney Meshkov (Univ. of Pittsburgh). p.653-9 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

An intermediate coupling calculation was carried out using a central two-nucleon potential in an attempt to describe the properties of C^{12}. The energy levels up to 16 Mev are given. The T = 0, J = 0, 2, and 4 and the T = 1,

J = 1 energy matrices were diagonalized for various values of a/K and L/K. Energy splitting ratios and wave functions were also determined. (M.C.G.)

6912 THE SPIN-ORBIT COUPLING AND THE TENSOR FORCES IN HEAVY NUCLEI. Shuji Takagi (Osaka Univ.), Wataro Watari, and Masaru Yasuno. p.675-8 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

The origin of spin-orbit coupling in the nuclear shell model was studied. One process found to give an important contribution to spin-orbit coupling was that in which the incident nucleon could be exchanged with one of the nucleons in the target nucleus which was already deformed by the tensor interaction. It can be shown that this process results in a potential which acts on the incident nucleon, and that this potential contains the spin-orbit coupling if the tensor interaction acts between nucleons. (M.C.G.)

6913 INELASTIC PROTON-GAMMA ANGULAR CORRELATION FOR C^{12} AT 40 MEV. Harry S. Adams and Norton M. Hintz (Univ. of Minnesota, Minneapolis). p.679-81 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Measurements were made of the angular correlation between the excitation γ ray and the inelastic protons from the first excited state of C^{12} at a bombarding energy of 39 Mev. The coincidence rate for the Q = −4.43-Mev proton group vs. the angle of the γ detector is given for several angles of the proton detector. (M.C.G.)

6914 ELASTIC SCATTERING ANGULAR DISTRIBUTIONS OF PROTONS FROM Li^6 AND Li^7 AT 40 MEV. Sheau-Wu Chen and Norton M. Hintz (Univ. of Minnesota, Minneapolis). p.683-4 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Proton elastic scattering measurements were made at an energy of 39.7 Mev, using targets of Li^6 and Li^7. The absolute cross sections, plotted as ratios to Rutherford scattering, are estimated to be good within ±10%. The relative positions of the maxima and minima for the two isotopes are consistent with an $A^{\frac{1}{3}}$ variation of the nuclear radii. (M.C.G.)

6915 QUASI-ELASTIC SCATTERING INSIDE LIGHT NUCLEI AT 153 MEV AND PROTON BINDING ENERGIES. T. J. Gooding and H. G. Pugh (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.685-90 of "Nuclear Forces and the Few-Nucleon Problem. Volume II."

Binding-energy spectra were observed in (p,2p) events in which no restriction was placed on the particle energies. Lithium, beryllium, carbon, and calcium were used as targets and graphs of energy spectra for each are given. Angular correlations of protons scattered from specified states of carbon both in and out of plane were studied. (M.C.G.)

6916 SCATTERING OF He^3 BY NEON. J. Catalá, A. García Rodríguez, and J. Aguilar (Univ. of Valencia). p.691-4 of "Nuclear Forces and the Few-Nucleon Problem. Volume II." T. C. Griffith and E. A. Power, eds. New York, Pergamon Press, 1960.

The elastic and inelastic scattering of He^3 by neon was studied by means of photographic plates. The 1.51-, 4.10-, and 5.43-Mev states of Ne^{20} were observed. The angular distribution of the He^3 particles elastically scattered by Ne^{20} was compared with Rutherford scattering and an approximate value of 6.34 ± 0.40 fermis was obtained for the radius of the interaction using the diffraction formula for a strongly absorbing disk. (auth)

Particle Accelerators

6917 (MURA-589) LINEAR OSCILLATIONS ABOUT OFF-CENTER, FIXED POINT ORBITS. M. M. Gordon (Midwestern Universities Research Assn., Madison, Wis.). 1959. 14p. Contract AT(11-1)-384. OTS.

In the neighborhood of a nonlinear resonance there exist off-center, closed orbits, representing either stable or unstable fixed points in the phase space diagram. A calculation is given for the linear tune for such orbits for both the ν = N/3 and N/4 resonances. The variational method for calculating fixed point orbits directly from the primary equations of motion is discussed. (auth)

6918 (MURA-593) PERFORMANCE ESTIMATES FOR INJECTOR CYCLOTRONS. H. G. Blosser and M. M. Gordon (Michigan State Univ., East Lansing). Sept. 28, 1960. 38p. Contracts AT(11-1)-384 and AT(11-1)-872. OTS.

Available evidence on performance to be expected from injector cyclotrons is collected and reviewed. On the basis of this information, estimates are made of current, spot size, angular divergence, energy spread, and duty cycle for the extracted beam of possible 40- and 200-Mev injector cyclotrons. (auth)

6919 (ORO-333) RUN 26 FIELD INFORMATION. H. G. Blosser and D. A. Flanigan (Michigan State Univ., East Lansing). Oct. 1960. 12p. Cyclotron Project. Contracts AT(40-1)-2425 and AT(11-1)-872. (MSUCP-5). OTS.

Cyclotron magnet field data gathered in survey Run 26 are presented. The model magnet is described, and the field survey data are tabulated. (J.R.D.)

6920 (UCRL-9418) BEVATRON OPERATION AND DEVELOPMENT. XXVI. [Period covered] May, June, and July 1960. Walter D. Hartsough (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1960. 16p. Contract W-7405-eng-48.

Bevatron operation averaged 88% of the scheduled operating time. The experimental program was devoted for the most part to continued studies of K- and π-meson interactions, using propane, hydrogen, deuterium, and xenon bubble chambers and π^--p interventions, using counting techniques. Seventeen chemistry bombardments were made in the internal proton beam. (auth)

6921 (CEA-tr-X-238) PROJET DU CYCLOTRON DE 16 MeV—SYSTÈME REFROIDISSEUR DU CYCLOTRON 16 MeV. (16-Mev Cyclotron Project. Cooling System for 16-Mev Cyclotron). V. Lopasich, T. Bosanats, and M. Konrad (Institut za Nuklearne Nauke "Boris Kidric," Belgrade). Translated into French by Y. Kefeli. [n.d.] 6p.

The cooling system for the electromagnets, dee conduits, oscillator tubes, and target of the 16-Mev cyclotron is described. The system has a normal load of 152 kw and a maximum of 205 kw. The system of pipes, pumps, tanks, and valves is diagramed. The primary system cools the electromagnet and the oscillator. The secondary system is a 100 m^3 open concrete basin and two pumps. (T.R.H.)

6922 (UCRL-Trans-468) THE 800 KV CASCADE GENERATOR OF THE DEPARTMENT OF ATOMIC PHYSICS OF THE CENTRAL PHYSICAL RESEARCH INSTITUTE. Imre Merey. Translated by Francis S. Juhasz from Magyar Fiz. Folyóirat 3, 480-96(1955). 16p. (Includes original, 7p.). JCL or LC.

The development work and construction of an 800-kv cascade generator are described. (T.R.H.)

6923 (UCRL-Trans-600(L)) TRANSACTIONS OF THE SESSION OF THE ACADEMY OF SCIENCE, UKRAINIAN SSR ON PEACEFUL USES OF ATOMIC ENERGY. Translated from p.50-3 of "Trudy Sessii Akademii Nauk Ukrainian S.S.R. po Mirnomu Ispal'zovaniyu Atomnoi Energii." (A publication of Academy of Science, Ukrainian S.S.R., Kiev, 1958). 12p. (Includes original, 5p.). JCL or LC.

During the development of the focusing systems for the ion beams of a 20-Mev linear accelerator, it was proposed that for the electron lens a negative volumetric charge of high density be used which is generated inside a magnetron operating at the critical condition. This proposal is discussed and conclusions are presented. (W.D.M.)

6924 COHERENT RADIATION FROM THE ELECTRONS IN A SYNCHROTRON. Yu. M. Ado and V. V. Elyan. Atomnaya Energ. 9, 455-60(1960) Dec. (In Russian)

Coherent radiation from electrons along the 10 cm wave, corresponding to the 50th harmonics of electron reverse frequency, was studied for various distributions inside the separatrix. In most cases the theory of coherent electron emission was verified. However, a deviation from theory was observed with close to uniform electron distribution. The radiation is used for measuring electron phase oscillation frequencies and the adiabatic attenuation of the amplitude of phase oscillations. The experiments were carried out with a 280-Mev betatron synchrotron. (tr-auth)

6925 MODEL OF A RING PHASOTRON. V. A. Petukhov, I. Gabanets, A. A. Zhuravlev, M. Karmasin, V. I. Kotov, et al. Atomnaya Energ. 9, 491-3(1960) Dec. (In Russian)

A design is given of an annular phasotron with radial sectors which, by combining vortex and high-frequency fields, achieves electron beams up to 2 Mev. (R.V.J.)

6926 IMPROVED FOCUSSING NEAR THE CYCLOTRON SOURCE. W. I. B. Smith (Australian National Univ., Canberra). Nuclear Instr. & Methods 9, 49-54(1960) Oct. (In English)

The vertical focusing of a cyclotron beam near the ion source was experimentally investigated as a function of the phase of the beam relative to the dee voltage. Considerable improvement in the vertical focusing of the beam was obtained by offsetting the ion source and puller by 20° to the dee edge, and thus retarding by 20° the phase of the first turn. (auth)

6927 SYNCHROTRON MAGNET POWER CIRCUIT WITH A DISTRIBUTED CAPACITOR BANK. Sigurd Waaben (Princeton Univ., N. J.). Nuclear Instr. & Methods 9, 78-86(1960) Oct. (In English)

A synchrotron magnet ring circuit suitable for exciting the bending magnets with exactly equal d-c biased sinusoidal currents is described. A distributed series resonance excitation is made practicable by the introduction of network constraints on the capacitor potentials. The central network component is a transformer choke. The practicable arrangements of the choke topology may take various forms determined essentially by economic considerations. Model tests and analysis are given. (auth)

6928 OPTIMAL LENGTH OF THE ACCELERATING GAP OF THE MICROTRON. A. Paulin (J. Stefan Institut, Ljubljana, Yugoslavia). Nuclear Instr. & Methods 9, 113-14(1960) Oct. (In German)

The optimal length of the accelerating gap using field emission cathode was calculated. For the S-band microtron this length should be 5 mm in the 511 kev mode (a = 2) and 4 mm in the 255 kev mode (a = 3). (auth)

6929 ON THE PARTICLE LOSS AT A SYNCHRO-CYCLOTRON LIMIT RADIUS. V. P. Dmitrievskii (Dmitrievsky), V. V. Kolga, and B. I. Zamolodchikov (Joint Inst. for Nuclear Research, Dubna, USSR). Nuclear Instr. & Methods 9, 115-17(1960) Oct. (In English)

Resonance interaction of radial and vertical oscillations near n = 0.25 is considered. This resonance is shown to be more dangerous than a parametric excitation of vertical oscillations which is caused by the first harmonic in the magnetic field structure. (auth)

6930 ANALOG COMPUTER FOR CHARGED PARTICLE TRAJECTORIES. Robert H. Good (Univ. of California, Berkeley) and Oreste Piccioni. Rev. Sci. Instr. 31, 1035-9(1960) Oct. (BNL-4526)

An analog computer was applied to the problem of tracing the trajectories of a beam of charged particles such as is produced by high energy accelerators. The electrical circuit involved employs analogs for both quadrupole magnets and bending magnets, and thus it facilitates the determination of both the focal properties and the dispersion characteristics of the magnets; an accuracy of 2% was attained for some of the calculations made with the present instrument. (auth)

6931 INJECTION OF FAST NEUTRAL BEAMS INTO THE THREE-STAGE TANDEM ACCELERATOR. P. H. Rose, R. P. Bastide, A. B. Wittkower, D. L. Webb, C. H. Goldie, and J. Shaw (High Voltage Engineering Corp., Burlington, Mass.). Rev. Sci. Instr. 31, 1052-3(1960) Oct.

An experiment is described in which a beam of fast neutral atoms was injected into the terminal of a tandem accelerator. A second tandem was arranged in line with the first. By taking advantage of charge-exchange mechanisms these atoms were accelerated to 15 Mev by a three-stage process. (auth)

6932 MEASUREMENT OF BETATRON OSCILLATION FREQUENCIES IN THE COSMOTRON. M. Q. Barton (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr. 31, 1290-1(1960) Dec.

Coherent betatron oscillations are excited by an impulse magnetic field in one straight section of the cosmotron. The resulting oscillations can be observed using a communications receiver connected to the radial position induction electrodes. (auth)

6933 ON THE THEORY OF MOVEMENT OF PARTICLES IN THE ACCELERATOR WITH VARIOUS MULTIPOLE–MICROTRON. A. A. Kolomenskiĭ (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz. 30, 1347-54(1960) Nov. (In Russian)

The motion of particles in an accelerator with a variable multipole microtron differs from all other cyclic accelerators. A method is suggested for investigating the particle behavior by means of equations with finite differences. The results are used for selecting accelerator parameters and for evaluating performance. (tr-auth)

6934 SPHERICAL ABERRATION OF A FOUR-POLE MAGNETIC LENS. M. G. Markovich and I. I. Tsukkerman. Zhur. Tekh. Fiz. 30, 1362-8(1960) Nov. (In Russian)

The spherical aberration of a short, four-pole magnetic lens was calculated. In a "symmetric" four-pole lens the aberration has the same sign as in lenses with rotational

symmetry. Conditions for measuring the sign of spherical aberration in nonsymmetric lenses are presented. (tr-auth)

Plasma Physics and Thermonuclear Processes

6935 (ARL-TR-60-306) AN INVESTIGATION OF TRANSPORT PROPERTIES OF PLASMAS USING THE LINEARIZED BOLTZMANN EQUATION (thesis). Kaya Imre (Michigan. Univ., Ann Arbor. Research Inst.). July 1960. 75p. Contract AF33(616)-5585. (UMRI-2756-2-T).

A study of the transport properties of plasmas, which are representable by a set of linearized Boltzmann equations coupled with Maxwell's field equations, is attempted for the case in which the collision integrals are replaced by a simple relaxation-type model. Relations, explicit in terms of the initial conditions, are deduced for the plasma parameters such as electric conductivity, mobility, and ordinary and ambipolar type diffusions. The results of some of the earlier treatments are rederived in the context of the formalism developed. Particular attention is given to a possible explanation of the experimentally observed high diffusion rates across an externally applied magnetic field, based on the effect of the off-diagonal elements of the plasma parameters. The general conclusion can be drawn that an "appropriate" study of the transport properties of plasmas may be performed in the framework of the present mathematical representation, in the sense that the results of the former treatments based on different approaches can be rededuced when a suitable approximation technique is employed. (auth)

6936 (LAMS-2488) QUARTERLY STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING NOVEMBER 20, 1960. (Los Alamos Scientific Lab., N. Mex.). Dec. 1960. 41p. Contract W-7405-eng-36. OTS.

In the entropy-trapping experiment, measurements were made of the energy of the ions escaping through the ring cusp of the picket-fence magnet. Ion energies from 50 ev to 3 kev were observed, the 50 ev particles lasting ~20 μsec and the 3 kev particles disappearing ~3 μsec after plasma injection. Indications are that these particles are not from the trapped high-β region in the central volume of the magnet but are rather single particles which are directed from the gun along magnetic field lines out of the ring cusp. The design of a large caulked picket-fence machine (vacuum vessel, 150-cm diameter and 300-cm long) was completed. The search for a contained beam of injected 7.0-kev protons in the skew-trapping experiment was continued for the symmetric magnet configuration. When the beam is injected ~2.5 cm off axis and inclined 5° to the plane of the axis, a detector located in the ring cusp exhibits a persistent tail ~100-μsec long after the beam has been pulsed off. It is not known whether this signal represents an ion beam contained for these times or whether it is due to (a) perturbations in the injector from stray magnetic fields or (b) residual electrons in the containment volume striking the detector. The first phase of the diagnostic program on the behavior of the plasma in a coaxial gun was completed. A qualitative picture of the gun's performance was obtained. Measurements on the yield of d-d neutrons from Perhapsatron S-5 Zeus show dependences on the B_z stabilizing magnetic field, applied voltage, and gas pressure similar to those observed earlier with the smaller machines. Impurity radiation (3500 to 8000 A) consisting of a strong continuum with broadened line spectra (predominantly silicon and oxygen) is observed with an onset time near peak gas current (~30 μsec after initiation of the gas discharge). The electron density in the microwave scattering experiment was increased by a factor of 50 to a value of about 10^{10} electrons/cm^3 by the addition of small quantities of krypton and mercury. The radiation pattern produced by the primary power S-band horn was examined and it is estimated that the intensity of the primary beam inside the bottle is approximately 1/40 watt/cm^2. Kerr cell photographs were taken of the discharge in the orthogonal pinch experiment. The photographs showed weak diffuse regions of light which had some boundary irregularities during the second half-cycle. X-ray photographs made with a pinhole camera through a thin (~225 μg/cm^2) aluminum-Zapon window gave images which indicate a region of hot electrons ($0.1 < T_e < 0.5$ kev) of diameter 1.2 to 2.0 cm. The striking conclusion was reached that the energy loss in Ixion, leading to the voltage-limiting effect, which arises from current drawn across the device, resides predominantly in hard ultraviolet radiation from impurity ions, much as in the case of the toroidal pinch Perhapsatron S-4. A major portion of the Ixion plasma is fully ionized; hence, ion-neutral and electron-neutral collisions need not be invoked to account for the voltage limiting process. There is now reason to believe that the ion energy may be raised to the kev region if a clean system is constructed. A new plasma accelerator—the E X B gun—is being constructed in place of the old Ixion. Construction of Scylla III was completed. After delays occasioned by electrical and mechanical difficulties, the machine was fired, using second half-cycle operation. The neutron yield increased by an order of magnitude. Work on a preionizer is proceeding. X rays from Scylla I were successfully diffracted with the beryl crystal soft x-ray spectrometer. Previously unobserved Lyman and helium-like singlet and triplet series lines were observed in the spectra of O VIII, Ne IX, and Ne X when these elements were introduced into the gas of the discharge. Installation of the first half of the Zeus capacitor bank was essentially completed, and preparations are underway for testing the newly installed sections. Work is proceeding on the conversion of one tier of the bank to a faster (low-inductance) transmission system. Development work has been proceeding on a fast parallel plate capacitor; two prototype units were constructed and are being evaluated. (For preceding period see LAMS-2464.) (auth)

6937 (MIT-NSL-TR-319) PRESSURE DATA OBTAINED FROM A CONTINUOUSLY FLOWING PLASMA. Charles F. Talbot (Massachusetts Inst. of Tech., Cambridge. Naval Supersonic Lab.). Jan. 1960. 25p. (NP-8904).

Data are presented on the static-pressure profile associated with the continuous flow of partially ionized helium through a tubular test section. The data yielded were insufficient to fix the state of the flow; several hypotheses are advanced to explain the behavior. (auth)

6938 (NASA-TN-D-507) RADIO TRANSMISSION THROUGH THE PLASMA SHEATH AROUND A LIFTING REENTRY VEHICLE. Macon C. Ellis, Jr. and Paul W. Huber (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). Jan. 1961. 23p. OTS.

Plasma-signal-attenuation concepts related to hypersonic reentry are reviewed. Attenuation experiments are described in which telemetry and microwave signals are

transmitted through a simulated flight plasma. Computations of plasma conditions about typical reentry shapes are made to show effects of body bluntness, angle of attack, velocity, and altitude on the plasma frequency and collision frequency in the shock layer. It is concluded that signal frequencies of the order of 10 kmc are required to avoid sudden signal blackout during a critical part of a lifting reentry flight. Areas of needed research are outlined. (auth)

6939 (ORNL-3011) THERMONUCLEAR PROJECT SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1960. (Oak Ridge National Lab., Tenn.). Jan. 13, 1961. 154p. Contract W-7405-eng-26. OTS.

Progress is indicated in DCX-1 operation and performance, DCX-2 design, vacuum arc research, ion source and accelerator development, theory and computation, instrumentation, magnetic fields and coils, spectroscopy, H_2^+ cross sections, vacuum systems and techniques, and ball lightning observations. Separate abstracts were prepared for each section. Design and support work on DCX-EP-B was issued as ORNL-3044 (Official Use Only). (For preceding period see ORNL-2926.) (W.D.M.)

6940 (ORNL-3011(p.1-12)) DCX-1 OPERATION AND PERFORMANCE. C. F. Barnett, J. L. Dunlap, et al. (Oak Ridge National Lab.).

DCX-1 was relocated and modified by the addition of vacuum pumps fast enough to accommodate operation with a deuterium arc. The new pumps have given about the expected pressure improvement in the outer vacuum system, but for reasons not fully understood, the vacuum in the inner system (liner) has not fallen below about 10^{-5} mm mercury with the deuterium arc in operation. Further work on the deuterium arc will be required to improve the situation. Measurements of the energy distribution of the H^0 particles that emerge from the trapped circulating "300-kev" H^+ beam were made. The H^0 particles are allowed to charge themselves by passing through a gas cell, and the resulting H^+ ions are energy-analyzed electrostatically. By correcting the charge-exchange cross section, the energy spectrum of the neutrals can be made to yield the energy spectrum of the trapped "300-kev" protons. In the median plane, using gas break-up, the trapped protons show little energy degradation, but when the carbon arc is used for break-up, the energy spectrum spreads both upward and downward. The spread seems to be accentuated off the median plane. Efforts were made to correlate the mean containment times τ of the circulating protons with the composition of the residual gas in the DCX-1 liner. A mass spectrometer is used to measure the composition. There is some qualitative correlation, the $1/\tau$-vs.-pressure curves showing increased slope at the low end of the pressure range, where gases other than H_2 predominate. (auth)

6941 (ORNL-3011(p.13-30)) DCX-2 DESIGN. P. R. Bell, J. S. Culver, et al. (Oak Ridge National Lab., Tenn.).

A description is given for a projected apparatus in which a 600- or 900-kev molecular ion beam (H_2^+, H_3^+, D_2^+, or D_3^+) is injected into a magnetic mirror containment volume and is made to pass repeatedly through a dissociative arc. Conditions are calculated under which, after an initial build-up of a trapped atomic-ion population, the arc could be turned off, and dissociation of the molecular ions could continue upon the atomic ions. The simultaneous requirements of injected H_2^+ beam current, beam collimation, vacuum conditions, and magnetic field shaping are discussed, and it is concluded that they are attainable. (auth)

6942 (ORNL-3011(p.31-56)) VACUUM ARC RESEARCH. (Oak Ridge National Lab., Tenn.).

Spectroscopic Doppler shift measurements in the carbon arc show longitudinal motion of C^{2+} in the peripheral region of the arc column near the cathode while inside the column there is little longitudinal motion, suggesting a local origin for the latter ions. Line broadening for C^{2+} ions suggests a temperature comparable to that of the C^{2+} ions, viz., 800,000°K. A decrease of line width was observed with an increase of arc current—possibly a consequence of a secondary pressure change. A theoretical treatment of the distribution of carbon ions outside of the carbon arc gives a magnetic field dependence in agreement with experiment, but the relative behavior of C^+ and C^{2+} is unexplained. A summary of the microscopic properties of the carbon arc is given. Lithium vacuum arcs can be successfully operated using vapor feed at the anode. They are brilliant green in color, because of the 5485 A line group of Li^+. The ionic composition of the arc is uncertain. A deuterium arc was operated in DCX-1. A 200-amp 185-volt arc gave about 2% dissociation of 600 kev H_2^+ ions, but since pumping was inadequate, the lowest liner pressure was only 1.5×10^{-5} mm Hg. The presence of the Balmer lines in the spectrum of the deuterium arc is thought to arise from the background gas rather than from recombination in the arc column. The anode of the deuterium arc dissipates about $^2/_3$ of the input power. In other work on gas arcs (e.g., deuterium) some gas is fed into the cathode. After establishment of an arc, reduction of cathode gas feed can cause the electron stream to "blow up" into a hollow cone. The possibility of using such an electron stream to burn out the background gas in a DCX-like device is discussed. (auth)

6943 (ORNL-3011(p.57-64)) ION SOURCE AND ACCELERATOR DEVELOPMENT. O. B. Morgan, G. G. Kelley, et al. (Oak Ridge National Lab., Tenn.).

Attempts are described to maximize the Von Ardenne source output of molecular ions (H_2^+). In the current range 20 to 50 ma, 70 to 80% of the output of hydrogen ions are H_2^+; at 50 to 100 ma, the H_2^+ current comprises 60 to 70% of the total. A sensitivity of the H_2^+ ratio to source pressure and to the spacing between intermediate electrode and anode was established, but several other factors were shown not to affect the H_2^+ ratio appreciably. A description is given of an accelerator tube now under test, which is designed for the acceleration of an ion beam of a few tenths of an ampere (direct-current) into DCX-2. (auth)

6944 (ORNL-3011(p.65-77)) THEORY AND COMPUTATION. A. Simon, E. G. Harris, et al. (Oak Ridge National Lab., Tenn.).

A generalization of the Rostoker-Rosenbluth expansion of the Liouville equation was used to obtain a set of coupled integral equations for the pair distribution functions of particles and radiation. These equations were solved exactly for the case of a static spatially homogeneous plasma with no external fields. The method is a generalization of that of Lenard. The result yields the Fokker-Planck coefficients including transverse interactions. An estimate of the plasma potential to be expected in DCX-like devices shows that so long as the positive ion density remains less than that of the neutrals, the potential cannot be expected to exceed a few volts. A Brinkman-Kramers calculation of the electron capture cross section of H_2^+ gave values ranging from $<8.6 \times 10^{-16}$ cm^2 at 30 kev to $<2.1 \times 10^{-18}$ cm^2 at 225 kev. Graphic results of further computation are given

concerning the containment zones and particle distributions in DCX-1. (auth)

6945 (ORNL-3011(p.78-9)) INSTRUMENTATION. H. Postma and J. A. Ray (Oak Ridge National Lab., Tenn.).

Silicon surface-barrier detectors were made to operate successfully in DCX-1. They gave good resolution of the 600-kev H_2^0 particle peak from that of the 300-kev H^0 particles. The energy response is linear. (auth)

6946 (ORNL-3011(p.80-101)) MAGNETIC FIELD CALCULATION, ION TRAJECTORIES, AND MAGNETIC COIL DESIGN. D. L. Coffey, W. F. Gauster, et al. (Oak Ridge National Lab., Tenn.).

The design of magnetic mirror fields with central zones homogeneous to about 0.1% in field strength is described. Computational codes were evolved for this and related purposes. A Fourier treatment is given for evaluation of the ripples produced in a long solenoid by lumping of the coils. A "model" is described which with four coils simulated closely the external field to be expected from a long device such as DCX-2. Preliminary consideration is given to the design of an injection snout for DCX-2, and tests of a model are described with a calculation of the effect of the end perturbation on ion orbits. An engineering investigation of various methods of connecting heavy-water-cooled electrical conductors is reported, leading to the conclusion that soft solder is good for joints that need not be broken, and suggesting favorable choices for detachable joints. (auth)

6947 (ORNL-3011(p.102-4)) SPECTROSCOPIC INSTRUMENTATION. G. K. Werner (Oak Ridge National Lab., Tenn.).

Inexpensive transmission gratings are found to be useful in simple slitless spectroscopes, provided that high resolution is not required. They can be used either visually or photographically, they give a stigmatic image, and can have apertures of f/1 or higher. (auth)

6948 (ORNL-3011(p.105-113)) H_2^+ CROSS-SECTION MEASUREMENTS. D. P. Hamblen, H. Postma, et al. (Oak Ridge National Lab., Tenn.).

The cross section for H_2^+ attenuation in H_2 gas and the cross section for proton production by H_2^+ in H_2 gas were remeasured in the energy range 200 to 600 kev. The results agree well with those of Sweetman at the lower end of the energy range, and with the earlier results of Barnett at the high energy end. (auth)

6949 (ORNL-3011(p.114-33)) VACUUM SYSTEMS AND TECHNIQUES. C. E. Normand, F. A. Knox, et al. (Oak Ridge National Lab., Tenn.).

The speed of the National Research Corporation 32-in. diffusion pump is found to be about 14,000 liters/sec for air and 21,000 liters/sec for hydrogen, at the valve inlet. Other performance characteristics of this pump are described. Two systems for the testing of evaporative pumping are described, together with the results of speed and saturation tests. Various methods of evaporation are compared; one that looks promising is titanium evaporation from a titanium-tantalum alloy; another is evaporation from a titanium-niobium alloy. The comparative response of various ionization gages was measured on a common system, relative to an absolute pressure response obtained from a leak. The results are expressed in terms of emission currents to be used with different makes of gages in order to give the same pressure readings. (auth)

6950 (ORNL-3016(p.311)) FOKKER-PLANCK COEFFICIENTS FOR A PLASMA INCLUDING RADIATION. A. Simon and E. G. Harris (Oak Ridge National Lab., Tenn.).

The pair-correlation equations, obtained from a generalization of the Rostoker-Rosenbluth expansion to include radiation, were solved exactly for the special case of a plasma whose zero-order distribution is static, uniformly distributed in space, and with no external magnetic or electric fields. The results are directly interpretable as coefficients of the Fokker-Planck equation. (auth)

6951 (ORNL-3016(p.311-12)) DISPERSION RELATIONS FOR PLASMA WAVES IN A FINITE CYLINDRICAL MEDIUM. P. B. Burt (Oak Ridge National Lab., Tenn.).

A dispersion relation for perturbations of a finite cylindrical shell of plasma was derived. The external magnetic field is assumed uniform, and for purposes of simplification, perturbation of the magnetic field is neglected. The result of the development is a set of somewhat complicated coupled differential equations in the radial variable. No apparent simplification appears evident. (auth)

6952 (ORNL-3037) EFFECT OF ENERGY DEGRADATION ON THE CRITICAL CURRENT IN AN OGRA-TYPE DEVICE. T. K. Fowler (Oak Ridge National Lab., Tenn.). Jan. 13, 1961. 23p. Contract W-7405-eng-26. OTS.

The relation between the trapped ion density achieved in a machine-like OGRA and the molecular ion injection current required, the S-curve calculated by Simon, was extended to include the effect of energy transfer from trapped ions to the continuous flux of cold electrons released in the ionization of the neutral background. Because the cross section for charge exchange, the process by which ions are lost before burnout, increases sharply with decrease in energy, even a little degradation greatly increases the ion loss rate and thereby increases the injection current required to sustain a given density. A revised result for the critical current for burnout determined from the S-curve is about twice that calculated neglecting ion energy degradation for the case of injecting 600 kev H_2^+. New S-curves and the critical current for a range of H_2^+ injection energies from 500 to 800 kev are presented. (auth)

6953 (R60SD454) PLASMA PROPULSION—PERFORMANCE OF A T-TUBE PLASMA ACCELERATOR FIRED INTO A VACUUM. P. Gloersen, B. Gorowitz, G. Bethke, and W. Palm (General Electric Co. Missile and Space Vehicle Dept., Philadelphia). Oct. 1960. 26p. Contract [AF]04(647)-269.

A study of the performance of various plasma accelerators operating under pressure conditions simulating those of outer space was continued, resulting in additional evidence to support the contention that such devices will find eventual application as propulsive units for space flight. In particular, investigations initiated previously on pulsed gas entry T-tube accelerators fired into high vacuum were extended to provide a more realistic picture of accelerator performance. Included in the additional techniques employed are streak photography, calorimetry, Kerr Cell photography, and spectroscopy. A discussion of both the quantitative and qualitative results of these studies and of their significance in a practical evaluation of the operating characteristics of a T-tube plasma motor is presented. (auth)

6954 (TID-11273) FREQUENCY SPECTRA OF LOW-FREQUENCY FLUCTUATIONS IN A PLASMA. F. W. Crawford (Stanford Univ., Calif. Microwave Lab.). Nov. 1960. 27p. Project Agreement No. 1. Contract AT(04-3)-326. (ML-762). OTS.

Observations were made of the low-frequency fluctuations occurring in hot-cathode d-c mercury-vapor discharges at a pressure of ~1μ. A spectrum analyzer was employed to study frequency spectra from three widely-differing experimental tubes and to determine the effects of variations in tube geometry, electrode spacing, and anode current. Similar measurements were also made at points along a long discharge column with the aid of a capacitive probe sliding on the outside of the tube. The character of the spectrum is markedly dependent on tube geometry, substantially independent of column length and position along the column, and may be coarse or contain relatively pure frequency components. One mechanism observed involved frequency variation proportional to the square root of anode current; a possible explanation is given. There is, however, evidence for the existence of other basic mechanisms of generation. (auth)

6955 (UCRL-6079) VELOCITY-SPACE INSTABILITIES IN THE MIRROR MACHINE. Richard F. Post (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1960. 26p. Contract W-7405-eng-48. OTS.

The conditions under which two types of velocity-space plasma instabilities might occur in the mirror machine are examined. The instabilities considered are unstable electron plasma oscillations and unstable hydromagnetic disturbances originating in velocity-space anisotropies. (C.J.G.)

6956 (UCRL-9393) CONTROLLED THERMONUCLEAR RESEARCH QUARTERLY REPORT [FOR] JUNE, JULY, AUGUST 1960. (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Livermore. Lawrence Radiation Lab.). 107p. Contract W-7405-eng-48. OTS.

Brief summaries are given for the various projects under investigation in the magnetic mirror program, Astron program, Livermore pinch program, Berkeley plasma research, theoretical and basic experimental plasma physics, and engineering and technological development. (For preceding period see UCRL-9243.) (auth)

6957 (AEC-tr-4177) MAGNETOACOUSTIC RESONANCE IN PLASMA. (Magnito-Zvukovoĭ Rezonans v Plasme). D. A. Frank-Kamenetskiĭ (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). Translation. 1960. 11p. OTS.

Also published in Zhur. Tech. Fiz. 30, 893-8(1960).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 26380.

6958 (ARC-21510) INVESTIGATION OF THE PLASMA STREAM EMANATING FROM A HIGH-PERFORMANCE ARC. Richard Weiss. Translated by T. G. Ross from Z. Physik 138, 170-82(1954). 17p. (AD-239783).

Two different types of water-stabilized high-performance arcs are given, in which the plasma stream emitted through a ring-shaped electrode is easily accessible for the purpose of investigation. For an arc length of 5 cm, a channel diameter of 7 mm, and an arc current of 150 amp, a plasma stream of 4 cm maximum length is obtained. Instantaneous photographs show the occurrence of a subsidiary arc outside the column of the arc, which produces the electrical contact between plasma stream and ring electrode; however, it is possible to generate a currentless plasma stream over a period of 5 sec after ignition. Simple criteria for the absence of current are given. The temperature distribution, degree of ionization, and axial flow velocity of the plasma stream are measured. It is demonstrated that the static energy content of 1 cm^3 of column of arc, irrespective of the channel cross-section and current strength, as well as being extensively insensitive to the radial temperature distribution, is always of the same magnitude. The effect of magnetic fields on the plasma stream is investigated. (auth)

6959 "RETURNING" LAYER THEORY. V. N. Zhigulev (Zhukovskii Central Inst. of Aero-Hydrodynamics, USSR). Doklady Akad. Nauk S.S.S.R. 134, 1313-16(1960) Oct. 21. (In Russian)

It was previously shown that the "returning layer" is the interface separating the magnetic field and plasma flow where the magnetic field increases from zero to a certain finite magnitude H_{max} when an electric field is present. Moreover, the magnetic and electric fields are self-congruent, i.e., they are produced by the motion of charged particles in the "returning layer." The theory of a relativistic "returning layer" is analyzed for the case in which the plasma velocity is perpendicular to the layer. Equations were derived for the "returning layer" and the order of terms was investigated. An accurate solution was derived for the case of nonrelativistic motion in a "returning layer" of plasma particles having identical charged particle masses; an approximate solution was found for a real, nonrelativistic plasma of protons and electrons. A new electron acceleration mechanism is discussed. (R.V.J.)

6960 HELICAL MOTION IN MANY COMPONENT MAGNETOHYDRODYNAMICS. V. S. Tkalich and E. F. Tkalich. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Mekh. i Mashinostr. No. 5, 184-6(1960) Sept.-Oct. (In Russian)

Through the use of Maxwell's equations, the continuity equation, the hydrodynamic equations of motion, and the assumption of time independence, a system of general equations was developed for a many component magneto-hydrodynamic description of a plasma of N ionic states. A linear differential operator reduced these equations to the form of the curl of the magnetic field proportional to the magnetic field. The eigenfunction solutions, H_k, of this equation permitted the construction of the magnetic field H from a superposition of these helical fields H_k. Further reductions permitted the solution of the two-component plasma velocity field in terms of the magnetic field. (TTT)

6961 PLANAR FLOW OF AN ELECTRICAL CONDUCTING LIQUID IN AN ALTERNATING MAGNETIC FIELD. L. Yu. Ustimenko and E. I. Yantovskiĭ. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Mekh. i Mashinostr. No. 5, 187-8(1960) Sept.-Oct. (In Russian)

The equations for a liquid of known electrical conductivity flowing in an alternating magnetic field were developed in terms of the coefficient of rotational force and the angle the field makes with the streaming fluid. The practical meaning of this development shows a possible exchange of energy between a stream of electrically conducting liquid and a rotor turning with speed V_s creating a transverse magnetic field in a ring-shaped canal between the rotor and an electrical conducting stator. (TTT)

6962 BINARY CORRELATIONS IN IONIZED GASES. R. Balescu and H. S. Taylor (Université Libre, Brussels). Phys. Fluids 4, 85-93(1961) Jan.

An equation of evolution for the binary distribution function in a classical homogeneous, nonequilibrium plasma was derived. It is shown that the asymptotic (long-time) solution of this equation is the Debye distribution, thus providing a rigorous dynamical derivation of the equilibrium

distribution. This proof is free from the fundamental conceptual difficulties of conventional equilibrium derivations. Out of equilibrium, a closed formula was obtained for the long living correlations, in terms of the momentum distribution function. These results should form an appropriate starting point for a rigorous theory of transport phenomena in plasmas, including the effect of molecular correlations. (auth)

6963 APPROACH TO EQUILIBRIUM OF A QUANTUM PLASMA. R. Balescu (Université Libre, Brussels). Phys. Fluids 4, 94-9(1961) Jan.

The treatment of irreversible processes in a classical plasma [R. Balescu, Phys. Fluids 3, 62(1960)] was extended to a gas of charged particles obeying quantum statistics. The various contributions to the equation of evolution for the reduced one-particle Wigner function were written in a form analogous to the classical formalism. The summation was then performed in a straightforward manner. The resulting equation describes collisions between particles "dressed" by their polarization clouds, exactly as in the classical situation. (auth)

6964 INDUCED OSCILLATIONS IN A RAREFIED PLASMA IN A MAGNETIC FIELD. P. S. Greifinger (RAND Corp., Santa Monica, Calif.). Phys. Fluids 4, 104-8(1961) Jan.

The excitation of collective plasma motion by a small charged object moving through a low-density unbounded plasma in an external uniform, static magnetic field is considered. The energy loss per unit path length due to the excitation of collective plasma motion was found as a function of magnetic field strength for an arbitrary angle between the velocity of the object and the field direction. It was assumed that the ion temperature is zero and the velocity of the charged object is small compared to the mean thermal electron speed. (auth)

6965 INTERACTION OF A STREAMING PLASMA WITH THE MAGNETIC FIELD OF A LINE CURRENT. James Hurley (New York Univ., New York). Phys. Fluids 4, 109-11(1961) Jan.

The interaction between the magnetic field of a line current and a rare plasma streaming toward it was investigated. It was assumed that the field of the line current was confined to a cavity with the plasma particles specularly reflected in a thin layer of the cavity wall. The shape of the cavity wall and the field in the cavity were calculated. (auth)

6966 PINCH WITH ROTATING PLASMA. E. Gerjuoy and M. N. Rosenbluth (General Atomics Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids 4, 112-22(1961) Jan. (GA-1353)

The magnetohydrodynamic stability of an infinitely conducting incompressible plasma, in the shape of an infinitely long circular cylinder within an external conductor, compressed by external B_0 and B_z against internal B_z, was investigated for the circumstance in which the plasma has an angular velocity about the z axis of the cylinder. Two different cases are examined in detail: arbitrarily large constant angular velocity, in which case the differential equation for the perturbed total (magnetic plus hydrodynamic) pressure inside the plasma is solved exactly in terms of Bessel functions; and nonconstant but small angular velocity, in which event perturbation theory can be employed. For both these cases the rotating plasma is less stable than the nonrotating plasma. (auth)

6967 EXPERIMENTS WITH PLASMA MOVING THROUGH NEUTRAL GAS. Ulf V. Fahleson (Royal Inst. of Tech., Stockholm). Phys. Fluids 4, 123-7(1961) Jan.

The behavior of a rotating plasma machine was investigated. It was found that when the gas pressure and the current are varied within very wide limits the burning voltage remains constant. The voltage is proportional to the magnetic field. The reason for this behavior seems to be the existence of a critical velocity, above which a strong interaction between a plasma and a neutral gas takes place. (auth)

6968 VELOCITY AND IMPULSE OF AN ACCELERATED PLASMA. Alan Andrew and J. P. Fitzpatrick (Lockheed Aircraft Corp., Palo Alto, Calif.). Phys. Fluids 4, 160-1(1961) Jan.

The velocity and impulse of a plasma produced in a pinch discharge tube and then accelerated into a vacuum were measured. Using argon gas, the impulse and velocity were determined as functions of α, the half-angle subtended by the open electrode, and as a function of the mass of argon in the gas pulse. Maximums were obtained at about $\alpha = 35°$. (M.C.G.)

6969 EVIDENCE OF CONTAINMENT OF A 3-kev DEUTERIUM PLASMA. F. H. Coensgen, W. F. Cummins, W. E. Nexsen, Jr., and A. E. Sherman (Univ. of California, Livermore). Phys. Rev. Letters 5, 459-61(1960) Nov. 15. (UCRL-6193-T)

A report is given on the production and containment of a plasma in which the mean ion energy is ~3 kev and the electron temperature is ~50 ev. The plasma is produced by magnetic compression of a highly ionized but "colder" plasma which is injected into an initially evacuated chamber. The leading front of the plasma burst is trapped between the d-c barrier and a pulsed magnetic field where it is compressed and heated by the rising magnetic field. Adiabatic heating of the ions has been confirmed within the accuracy of the experiments. An estimate is given for the ion energy distribution at the end of the compression (70 μsec) in the plasma. After 70 μsec, the decay of the production rate is probably caused by decreases in mean ion energy and density caused by the decay of the pulsed field (700 μsec characteristic time). A histogram of neutron production is given for containment of at least 900 μsec. The plasma is contained for times which exceed the e-folding time for hydromagnetic instabilities by three orders of magnitude. The close agreement of the observed ion energy gain to that predicted from adiabatic theory indicates that the energy transport from ions to electrons does not greatly exceed the rate calculated on the basis of Coulomb collisions. (B.O.G.)

6970 ION RESONANCE IN A MULTICOMPONENT PLASMA. S. J. Buchsbaum (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters 5, 495-7(1960) Dec. 1.

Experiments with arc discharges in spectroscopically pure H_2, helium, or neon were performed to study the pure ion cyclotron resonance and its behavior with increasing plasma densities. Plots are presented (1) for the pure or almost pure ion cyclotron absorption lines in helium with a H_2 impurity and (2) for the absorption lines in relatively pure H_2 for various plasma densities as a function of the magnetic field. In (1), only the H_3^+ line is shifted toward lower magnetic fields, while in (2), all three lines (H^+, H_2^+, and H_3^+) shift toward lower magnetic fields as the plasma density is increased and the H_3^+ and H_2^+ lines cross the H_2^+ and H^+ cyclotron fields, respectively. The possible causes

of the linewidth behavior with density are discussed. (D.L.C.)

6971 SUPER-HIGH-FREQUENCY METHODS FOR PLASMA INVESTIGATION. V. E. Golant (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Zhur. Tekh. Fiz. 30, 1265-1320(1960) Nov. (In Russian)

A systematic review is given of super-high-frequency methods of plasma investigation. Methods based on plasma emission are not included. Plasma probing by weak, high-frequency fields obtain data on plasma conductivity. The relation of active and reactive plasma conductivity components to electron concentration and electron interaction frequency are used for determining plasma concentration and in analyzing electron interactions with atoms and ions. Conductivity measurements yield data used in evaluating mean electron energy (electron temperature). The influence of spatial plasma dispersion on plasma conductivity is analyzed. Theoretical bases and applications of resonator, wave guide, and free spatial methods are discussed. 96 references. (R.V.J.)

6972 NON-STABILITIES OF THE INDUCTIVE (THETA-) PINCH. I. F. Kvartskhava, K. N. Kervalidze, and Yu. S. Gvaladze (Kirov Ural Polytechnic Inst., USSR). Zhur. Tekh. Fiz. 30, 1321-8(1960) Nov. (In Russian)

Photographs of θ plasma pinch are presented and discussed. The pictures indicate exceptionally complex plasma motions and various forms of pinch instability. Some factors indicate the important part played by "escaping" electrons during induced instability. (tr-auth)

6973 TRANSITION STRAHLUNG OF THE PLATE IN THE WAVEGUIDE. K. A. Barsukov (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz. 30, 1337-46(1960) Nov. (In Russian)

Radiation emitted by a particle in flight through a dielectric plate placed in a waveguide is studied. The Vavilov-Cherenkov radiation and "closed in" radiation in the plate are discussed. (R.V.J.)

6974 IONIZATION PHENOMENA IN GASES. Gordon Francis. New York, Academic Press Inc., 1960. 305p.

A treatment is given of ionization phenomena in gases with emphasis on the physical principles involved and with examples selected from atmospheric phenomena and thermonuclear research. The seven chapters cover fundamental processes, the similarity principle, alternating and high-frequency discharges, ionization and excitation in the upper atmosphere, high-current discharges and thermonuclear effects, and plasma oscillations and waves. (D.L.C.)

6975 IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Peter Clive Thonemann and Robert Carruthers (to United Kingdom Atomic Energy Authority). British Patent 852,897. Nov. 2, 1960.

The discharge channel of a high-current ring discharge in a gas in a torus constituting the single-turn secondary winding of a pulse transformer may be stabilized after the eddy currents induced in the torus walls decay by installing a winding on the torus. The winding has two equal-turn portions connected in series opposition (currents flowing in opposite directions) and is arranged on the torus to produce a betatron-type transverse field within the torus when energized in synchronization with the primary winding; the betatron field prevents the discharge axis from expanding. (D.L.C.)

6976 IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Robert Carruthers and Peter Clive Thonemann (to United Kingdom Atomic Energy Authority). British Patent 854,246. Nov. 16, 1960.

A gas discharge apparatus for thermonuclear reactions is designed so that a ring discharge is induced in a gas contained in a torus by a capacitor charge-discharge arrangement which forms the primary winding of a transformer, the totus being the secondary winding. A second circuit is used to maintain the discharge current at a high value for a prolonged period to enable thermonuclear reactions to occur. Ignitrons are also used to prevent the voltage on the capacitor from reversing. (D.L.C.)

6977 METHOD AND MEANS FOR PRODUCING HIGH DENSITY PLASMAS. (to U. S. Atomic Energy Commission). British Patent 854,869. Nov. 23, 1960.

A pinch device for producing stable, dense plasma discharges for thermonuclear reactions is designed in which an auxiliary magnetic field in opposition to the induced magnetic field is used to reduce disrupting kink perturbations of the pinch column and to control its compression. The device produces pulsed linear discharges of a hollow cylinder geometry and of the same frequency as that of the auxiliary field. (D.L.C.)

Shielding

6978 (FZM-1987) RADIATION SHIELDING FOR SPACE VEHICLES. J. W. Keller and N. M. Schaeffer (Convair, Fort Worth, Tex.). June 15, 1960. 29p.

Presented at 1960 Pacific General Meeting American Institute of Electrical Engineers, San Diego, California, August 8-12, 1960.

Ramifications on shielding of manned space vehicles are being investigated in view of the existence of the intense radiation environment in space. The space radiation environment is reviewed, and the problem of selecting best shielding materials in view of this environment is treated. The results of preliminary calculations to determine requirements for shielding against Van Allen radiation and solar protons are given. These results indicate that for most missions (outside the heart of the inner Van Allen belt) exposure to solar protons will be the controlling factor in determination of shield weight, suggesting the possible use of two crew compartments—one for normal operations and a smaller heavily shielded one for occupancy following solar flares. (auth)

6979 (NP-9502) SHIELDING PROBLEMS IN MANNED SPACE VEHICLES. Semiannual Technical Summary Report [for] Period December 31, 1959–June 30, 1960. R. I. Allen, A. J. Dessler, J. F. Perkins, and H. C. Price (Lockheed Nuclear Products, Marietta, Ga.). 124p. Contract DA-01-009-506-ORD-832. (NR-104)

Results are presented from the first phase of a study of the shielding requirements for manned space vehicles, as imposed by the natural radiations to be encountered in space flight and the radiations from auxiliary nuclear power sources. The penetrating radiations in space are discussed and the reliability of various data is considered. Intensity, energy spectra, and spatial and time dependence of the various types of radiation are summarized in graphical and tabular form. The spatial distribution of trapped protons and electrons is presented in the form of contours of constant flux. The significance and general shielding implications of the more important penetrating radiations are treated. Computational methods for predicting dose rates due to trapped protons and electrons are formulated, and results of calculations are presented. Proton dose-rate

calculations are based on the energy spectrum as determined by Freden and White; bremsstrahlung dose rates are calculated on the basis of the low-altitude electron spectrum measurements of Walt et al., and of Holly and Johnson. It is found that attenuation of protons in shields of moderate thickness is governed largely by ionization energy losses; whereas inelastic nuclear collisions result in attenuation of the primary flux of protons and in the production of secondary radiations, which become significant for very thick shields. Proton dose rates at the center of the proton belt range from 20 rads/hr behind a 2 g/cm^2 shield to about 1 rad/hr behind a 100 g/cm^2 carbon shield. Light elements are most effective for proton shields since they offer combined advantages of large stopping power and relatively small production of low-energy secondary radiation. Carbon is a particularly effective element for proton shielding; its stopping power is exceeded only by that of hydrogen and helium. Hydrogenous compounds may prove to be suitable since the stopping power of hydrogen is more than twice that of any other element; and such compounds offer advantages of attenuation of both protons and secondary neutrons by nuclear collisions. Production of bremsstrahlung by electrons stopped in the vehicle exterior can be minimized by use of a thin outer layer of low-Z material. Bremsstrahlung dose rates in a lightly shielded vehicle reach values of several r/hr but are reduced to acceptable levels by 3 or 4 g/cm^2 of lead or uranium. (auth)

6980 (ORNL-3016(p.221-6)) DESIGN OF A SHIELD FOR THE ORR SOUTH FACILITY: EXPERIMENTAL PROGRAM AT BEAM HOLE HB-2. F. J. Muckenthaler and T. V. Blosser (Oak Ridge National Lab., Tenn.).

The thermal-neutron flux, fast-neutron and γ-ray doses, and fast-neutron and γ-ray spectra from beam hole HB-2 of the ORR were measured. The data will be used in the design of a portable shield for the ORR South Facility in connection with the installation there of the GCR loop No. 2. Experimental configurations included barytes concrete, iron, lead, polyethylene, and borated polyethylene, used either singly or in various combinations. An attempt was made to evaluate the dose from scattering by these materials. Only a sampling of the data is presented. (auth)

6981 (ORNL-3016(p.231-2)) DEVELOPMENT OF AN IBM 704 ANALYTICAL CODE FOR ANALYSIS OF AXIALLY SYMMETRIC REACTOR SHIELDS. F. B. K. Kam and H. E. Stern (Oak Ridge National Lab., Tenn.).

Analytic IBM 704 codes, intended to furnish neutron and γ data applicable to preanalysis of shielding experiments and to general shield design, were written. Fast neutron and primary γ doses outside of an axially symmetric reactor shield can be computed for detector points located along the axis of symmetry. Two subprograms are ready for use; the remaining codes are completed and are being debugged. (auth)

6982 (ORNL-3016(p.233)) DESIGN OF A REACTOR SHIELD. H. E. Stern and F. B. K. Kam (Oak Ridge National Lab., Tenn.).

A study of some of the problems inherent in the design of reactor shields for nuclear-powered aircraft was initiated. Calculational methods for obtaining optimum configurations are being explored. Initial attention was focused on γ rays born in a core and utilized a simple model for some approximate calculations. (auth)

6983 (ORNL-3016(p.245-6)) A STUDY OF CONCRETE SAMPLES TAKEN FROM THE TOP SHIELD OF THE ORNL GRAPHITE REACTOR. W. J. Grantham (Oak Ridge National Lab., Tenn.).

Samples secured during the drilling of experiment holes 70 and 71 in the ORNL Graphite Reactor were analyzed for water content and compressive strength. At the time of the drilling, the reactor had developed a total power of 4.3×18^8 kwhr. Results indicated a water content consistent with design anticipations, but the compressive strength of both the barytes-haydite and ordinary concretes fell significantly below the design strength of 2.5 ksi. (auth)

6984 RADIATION SHIELD REQUIREMENTS FOR TWO LARGE SOLAR FLARES. D. H. Robey (Convair, San Diego, Calif.). Astronaut. Acta 6, 206-24(1960). (In English)

The class 3+ flare of May 10, 1959, and the class 4 flare of February 23, 1956, were analyzed to determine the magnitude of radiation shielding required for man in space. The former was probably the largest flare of the year and the latter the largest flare on record. Carbon was selected for the shielding material. A spherical carbon shield configuration with an inside cavity of 90 cm radius was used for both events. It was found, that for the class 4 flare, all protons with energies below 1.4 Bev must be stopped in order to reduce the proton radiation dose to the order of 25 rem (RBE = 1). An optimistic estimate of the shield weight gave about 379 metric tons (834,000 lb), neglecting nuclear reactions. (auth)

6985 SHAPE OF THE ABSORPTION CURVE FOR BETA RAYS IN ALUMINIUM. N. E. Tsvetaeva. Atomnaya Energ. 9, 507-8(1960) Dec. (In Russian)

The absorption curves for simple β emission spectra with $E_0 = 200$ and 600 kev and atomic β emission number $Z = 4$, 20, and 80 were calculated by graphical integration. The half-absorption layers found by calculating the initial ($D_{1/2\ init}$) and mean ($d_{1/2\ mean}$) show a considerable difference. Moreover, $D_{1/2\ init}$ is a function of the β emitter atomic number. The experimental values for half-absorption layers ($D_{1/2\ init}$) for S^{35}, Ca^{45}, Co^{60}, and Sr^{90} correlated to the obtained data are in good agreement except for Sr^{90}. (R.V.J.)

Theoretical Physics

6986 (AD-238758) QUANTUM MECHANICAL THREE-BODY PROBLEM. [PART] II. Leonard J. Eyges (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). June 13, 1960. 52p. Contract AF19(604)-5200.

A method is presented for treating the following quantum mechanical three-body problem: to find the ground state eigenvalue and eigenfunction for a system of three identical particles between any pair of which there is an attractive central force. An essential point of the method is to assume the wave function Ψ has a special analytic form, $\Psi = \Psi(r_{12}, \rho_3) + \Psi(r_{13}, \rho_2) + \Psi(r_{23}, \rho_1)$ where $r_{12} = r_1 - r_2$, $\rho_3 = r_3 - (1/2)(r_1 + r_2)$, and r_{13}, ρ_2 and r_{23}, ρ_1 are defined analogously. The Schrödinger equation for the system can then be written as an integral equation for $\phi(k, \kappa)$, the Fourier transform of Ψ. This is expanded in Legendre polynomials, $\phi(k,\kappa) = \Sigma_{l=0}^{\infty} \phi_l(k,\kappa) P_l(\cos\gamma)$ and this yields a set of coupled integral equations for the $\phi_l(k,\kappa)$. These can be truncated and to a good approximation one can neglect all ϕ_l except ϕ_o, thereby reducing the problem to a single integral equation for a function of two variables.

An iterative scheme is proposed for solving this equation for the ground state eigenfunction, and a simple but accurate nonvariational method is suggested for deriving the energy eigenvalue therefrom. This proposed solution is tested by working it out in detail for the case of exponential interparticle potentials. The results for the eigenvalue compare favorably with variational calculations by other authors. The accuracy of the approximations and the possible sources of error in the wave function are discussed. (auth)

6987 (JINR-E-568) ON SOME PROBLEMS OF THE THEORY OF SUPERCONDUCTIVITY. N. N. Bogolyubov (Bogolubov) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 24p.

A review of the information on model Hamiltonian in the theory of superconductivity is presented. The simplest dynamic system characterized by the well-known reduced Hamiltonian is treated by methods that are completely mathematically rigorous. A general discussion of the theory of superconductivity and superfluidity is included. (J.R.D.)

REACTOR TECHNOLOGY

General and Miscellaneous

6988 (60RL-(2405E)) REACTOR STARTUP WITH STATISTICAL FLUCTUATIONS. H. Hurwitz, Jr. (General Electric Co. Research Lab., Schenectady, N. Y.). Apr. 1960. 37p.

In the early stage of the start-up of a reactor with a small source, statistical fluctuations may be important. The influence of these fluctuations will persist in the subsequent stage of the start-up when the power level is high in the sense that the early fluctuations provide a statistical distribution of initial conditions to be applied in the treatment of the high-level stage. In almost all cases of practical interest, the statistical stage will have terminated before the reactivity greatly exceeds delayed critical. Hence, it is possible to carry out the statistical analysis on the basis of the approximation that the prompt generation time is zero. From this viewpoint the elementary statistical event is the chain of prompt fissions caused when a single source neutron or delayed neutron is introduced into the assembly. The distribution function of delayed neutron progenitors from a single prompt neutron chain depends on the prompt reactivity at the time that the chain occurs. The calculation of this distribution function in terms of the distribution function for the emission of prompt neutrons is described. The method is based on the evaluation of the generating function by a Laplace transform procedure. The statistical distribution of progenitor population as a function of time during the start-up may be calculated in terms of the single prompt chain distribution function by generating function techniques, taking into account the dependence of reactivity on time. A formula is developed for the probability as a function of time that the delayed neutron progenitor population will be smaller than a specified number. A method for solving the generating function equation which is suitable for calculating this probability is suggested. This method leads to equations similar to but more powerful than the equations for the expectation value and second moment of the progenitor population. (auth)

6989 (ANL-6221) THEORETICAL FEEDBACK ANALYSIS IN BOILING WATER REACTORS. A. Ziya Akcasu (Argonne National Lab., Ill.). Oct. 1960. 66p. Contract W-31-109-eng-38. OTS.

The dynamic behavior of boiling-water reactors for small perturbations was investigated in a systematic way. General expressions for the transfer functions associated with the individual feedback mechanisms were obtained for an arbitrary flux distribution, weighting function, and steam velocity distribution. Specific forms were derived in the case of a first power flux weighting, a uniform steam velocity distribution, and a sinusoidal flux distribution with an adjustable wave length. These forms were simplified and single time-constant transfer functions were obtained. The error involved in the lumped time-constant approximation was shown to be as large as 4 db in amplitude in certain feedback mechanisms. Theoretical results were applied to the experimental power-void transfer function obtained at Ramo-Wooldridge Research Laboratory, and to the EBWR transfer function. In the former case, the agreement was found to be reasonably good, but yet more systematic experimental data were needed to reach a definite conclusion as to the validity of the proposed model, which assumes a time lag associated with steam formation and a steam perturbation speed greater than the steady-state steam velocity. In the second application, the agreement between the experimental and calculated reactor responses was proved to be better than 5 db in amplitude and 10° in phase, in the entire frequency range from 0.01 to 100 rad/sec. (auth)

6990 (BMI-1485) OPERATION AND MAINTENANCE OF AN IN-PILE GAS-COOLED LOOP AT THE BRR. Sam J. Basham and William G. Rieder (Battelle Memorial Inst., Columbus, Ohio). Dec. 14, 1960. 28p. Contract W-7405-eng-92. OTS.

A circulating-gas loop was operated 5574 hr in-pile at the Battelle Research Reactor to evaluate fuel materials and to obtain engineering data for the GCRE and ML-1. Two versions of the loop were used in the seven experiments. In the final design, 200-psig nitrogen-0.5 vol. % oxygen could be circulated at a rate of 1500 lb/hr through a 1.5-in.-ID by 24-in.-long instrumented test section to provide a heat-removal capacity of around 50 kw. Specimen-inlet and -outlet temperatures of about 800 and 1350°F, respectively, were possible. Maintenance procedures were developed over the operating period to handle several component failures. In every instance of component failure, repairs were made and operation was resumed with the same irradiation specimen. None of the seven experiments was terminated because of a failure in the loop components. (auth)

6991 (CF-59-5-79) DESIGN CRITERIA FOR A PILE OSCILLATOR. Lawrence Dresner (Oak Ridge National Lab., Tenn.). May 25, 1959. 7p. OTS.

An elementary discussion is given of the reactor parameters which determine the signal-to-noise ratio obtainable with a pile oscillator. (auth)

6992 (CF-60-10-137) LOCAL REACTIVITY "WORTH" IN THE HRT. S. Jaye and D. R. Vondy (Oak Ridge National Lab., Tenn.). Oct. 11, 1960. 13p. OTS.

The effect of adding small quantities of fuel or poison to the HRT was estimated using perturbation theory. The results were reduced to a single relation and a set of graphs, which make the estimation of added reactivity relatively simple. The perturbation theory results are compared

with multigroup results, and reasonable agreement is demonstrated; however, there is some question concerning the prompt neutron lifetime. The addition of 1 g of U^{235} at the center of the core, when no fuel is present in the blanket, leads to an increase in reactivity of 3.1×10^{-4}. If the uranium were added at the core wall or uniformly distributed throughout the core, the reactivity increase would be 1.4×10^{-4} and 1.8×10^{-4}, respectively. (auth)

6993 (CF-60-10-138) EXPIRE—A REACTIVITY LIFETIME CALCULATION. S. Jaye (Oak Ridge National Lab., Tenn.). Oct. 13, 1960. 31p. OTS.

EXPIRE is a calculation which predicts the reactivity-lifetime, instantaneous and integrated effective multiplication constants and instantaneous conversion ratio for heterogeneous reactors. The concentration of all the isotopes of interest from Th^{232} to Am^{243} are calculated as a function of time using the average reactor power density and a uniform flux distribution. The equations have been programed for the IBM-704 computer and the average running time is approximately two minutes per reactor lifetime. The calculation can be terminated when either of the effective multiplication constants falls below unity or when some predetermined fuel exposure is achieved. The effective resonance integrals and the fission product cross sections as a function of exposure are included in the calculation. Neutron fission and absorption at resonance energies are considered for all fuel isotopes. Spectral hardening of the thermal flux is considered and effective neutron temperatures are evaluated. Thermal flux disadvantage factors are calculated using a P_3 expansion of the single-energy Boltzmann equation. (auth)

6994 (CF-60-12-2) THE HELIUM PURIFICATION SYSTEM FOR THE PROPOSED 800 MWT PEBBLE BED REACTOR. C. D. Scott and J. C. Suddath (Oak Ridge National Lab., Tenn.). Dec. 7, 1960. 14p. OTS.

A helium coolant purification system was designed for the proposed 800 Mwt Pebble Bed Reactor. The purification system will operate on a coolant side steam with a flow rate 1% of the total coolant flow, and there are provisions for radioactive and nonradioactive contamination removal. Primary equipment components are dual oxidizers, an economizer heat exchanger, a gas cooler, dual absorbers, a fission-product gas-delay trap, and dual filters. The fission-product trap is sized to provide a hold-up of 30 min for krypton and 6 hr for xenon and for 99.9% retention of iodine. Nonradioactive decontamination is sufficient to maintain oxygen bearing contamination at < 30 ppm in the coolant. Total cost of the system excluding auxiliary equipment and containment was estimated to be $176,360. (auth)

6995 (CF-60-12-80) THERMAL NEUTRON FLUX AT THE HRE-2 CORE WALL, DETERMINED FROM ZIRCALOY-2 INDUCED-ACTIVITY MEASUREMENTS DURING RUNS 13, 14, 16, 17, 18, 19, 20 AND 21. J. E. Baker (Oak Ridge National Lab., Tenn.). Dec. 20, 1960. 6p. OTS.

The thermal-neutron flux prevailing near the upper hole in the HRE-2 core wall was determined from measurements of the induced activity in a specimen cut from the edge of the hole. The specimen was removed following run 21 and was thus exposed to reactor neutrons during runs 13, 14, 16, 17, 18, 19, 20, and 21. The neutron flux, calculated for an average core power level of 2 Mw, was 2.8×10^{13} neutrons/cm^2/sec. The core wall area from which the specimen was removed was located approximately 16 in. from the core center. The flux is compared with similarly derived values from thermal-neutron fluxes prevailing near some Zircaloy-2 specimens exposed during HRE-2 run 17, and near others exposed during runs 13, 14, 16, and 17. (auth)

6996 (HW-66215) NUCLEAR PHYSICS RESEARCH QUARTERLY REPORT FOR APRIL, MAY, JUNE 1960. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 20, 1960. 36p. Contract AT(45-1)-1350. OTS.

Progress is indicated on various research projects in the fields of theoretical, reactor, and critical mass physics. Separate abstracts were prepared for the eight sections of the report. (For preceding period see HW-64866.) (W.D.M.)

6997 (HW-66215(p.30-3)) CRITICAL APPROACH AND EXPONENTIAL MEASUREMENTS WITH 2.00 PER CENT ENRICHED URANIUM RODS IN LIGHT WATER. R. C. Lloyd, E. D. Clayton, and B. L. Jones (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Critical approach measurements were completed with 2.00% enriched, 0.925 dia. rods 16 and 32 in. long; exponential measurements were made with the 32-in. rod length. The rods were incased in lucite tubes for insertion in the water reflected lattice assemblies. The critical number of rods in cylindrical geometry and critical mass values for spherical geometry were determined. (W.D.M.)

6998 (HW-66215(p.34-6)) EXPONENTIAL MEASUREMENTS OF NATURAL URANIUM–WATER SYSTEMS. R. C. Lloyd (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A series of exponential measurements was completed with 0.925-in. dia. natural uranium fuel elements in light water. A plot of buckling vs. H_2O/U volume ratio is given. (W.D.M.)

6999 (HW-64866(p.65-87)) MATERIAL BUCKLINGS OF GRAPHITE URANIUM LATTICES. G. W. R. Endres and D. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Material buckling measurements were completed for a series of lattices with a tube-in-tube natural uranium fuel element for most lattice spacings with tube-and-rod and I and E fuel elements and for one lattice, using a second tube-and-rod fuel element. Bucklings were measured in exponential piles for both air and water coolant. Material buckling values and side-to-side extrapolation lengths for the tube-in-tube, tube-and-rod, and I and E fuel elements are shown. Dimensions, cladding, densities, volume ratios, and volumes per centimeter of length for the fuel elements are given. (W.D.M.)

7000 (HW-64866(p.92-104)) THEORY OF CONTROL ROD STUDIES IN EXPONENTIAL ASSEMBLIES. D. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The analytical methods necessary to interpret measurements of control-rod effects in an exponential assembly are discussed. The exponential method was developed within the limits of the theory of a bare, homogeneous, subcritical system. The theory of a central rod in a cylindrical exponential pile is developed with 1, 2, and 3 energy groups. Application of the data to a full-size reactor is shown in terms of a single fully inserted rod, with comments on normalizing theory in order to allow for partial or off-center insertion. (W.D.M.)

7001 (HW-64866(p.105-13)) PCTR MEASUREMENTS OF CONTROL ROD STRENGTH. P. F. Nichols and R. E. Heineman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Measurement of control-rod strength in PCTR is described. The problem is considered in the most simple manner possible, i.e., a one-group treatment of the measurement on an infinitely long control rod. The complications and refinements involved in a two-group treatment are then discussed for an infinitely long rod and for one of finite length. A measurement of the EGCR control-rod strength is interpreted with the use of the two-group method for a control rod of finite length. (W.D.M.)

7002 (HW-64866(p.114-25)) NEUTRON RETHERMALIZATION IN GRAPHITE IN CYLINDRICAL GEOMETRY. R. A. Bennett (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Experiments performed in the PCTR in the study of the space-energy distribution of neutrons in graphite-moderating media with nonuniform physical temperatures are described. Purposes of the experiments were to determine rethermalization cross sections of graphite as a function of the temperature of the media in which the neutrons are being moderated and to test the validity of the two-Maxwellian group model by comparison of calculated and measured traverses of the activity of a non-1/v detector like lutetium. Experimental curves and data are given together with a description of the experiments, method of analysis, and results obtained. (W.D.M.)

7003 (HW-64866(p.137-42)) NEUTRON MULTIPLICATION MEASUREMENTS WITH Pu–Al ALLOY RODS IN LIGHT WATER. V. I. Neeley, R. C. Lloyd and E. D. Clayton (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Neutron multiplication and exponential experiments were conducted with Pu–Al alloy rods having 5 wt. % plutonium enrichment. The rods were 24-in. long and 0.506-in. in diameter and were clad with 0.030-in. Zircaloy-2 with 0.020- and 0.125-in.-thick end caps. The average rod contained 11.01 g of plutonium. This gave a Zr/Pu of 31.92 and Al/Pu of 168.20. Experiments were conducted in the TTR reactor room. Experiments were conducted using critical approach, "back-off," and exponential measurement techniques. (W.D.M.)

7004 (HW-64866(p.148-9)) EXPONENTIAL EXPERIMENTS WITH POISONED MODERATOR. R. C. Lloyd (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A series of measurements was completed for determining the amount of neutron absorber required to make a heterogeneous system of 1.007% enriched uranium rods safe. The fuel rods (aluminum clad) were 0.925-in. in diameter and 44-in. long. Eighty-five of the fuel rods were loaded into a stainless-steel tank, and increments of boric acid (H_3BO_3) were added to the moderator until the buckling became negative. (W.D.M.)

7005 (NAA-SR-Memo-4240) SRE CRITICALITY WITH SEVEN SOLID ROD CLUSTER OF URANIUM CARBIDE FUEL. A. Aronson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 6, 1959. 13p. OTS.

Studies were made to determine the enrichment required to provide excess reactivity of 4.5% above hot and poisoned for various numbers of clusters of UC fuel in the SRE. The fuel element is in the form of seven-rod clusters 6-ft. long. A plot is given of effective multiplication constants (K_{eff}) vs. enrichment for cores consisting of 31, 37, and 43 clusters. The effects of additional clusters on reactivity with constant enrichment are shown. Cell thermal flux and core radial and axial thermal flux plots are given for 31 clusters with 5.0 at.% enriched fuel and are also plotted for 43 clusters with 4.0 at.% enriched fuel. (W.L.H.)

7006 (NAA-SR-Memo-5318) INERTIAL PRESSURE AND VOID FORMATION: GENERAL CONSIDERATIONS. C. Warner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 25, 1960. 14p. OTS.

A wave equation for the pressure in a mixture of water and gas bubbles (such as found in the KEWB Reactor) is derived. The driving force may be either the production of additional bubbles or the growth of existent bubbles. Several illustrative solutions to the wave equation are found. (W.L.H.)

7007 (NP-9655) VOORDRACHTEN GEHOUDEN, TIJDENS EEN SYMPOSIUM BETREFFENDE DE TOEPASSING VAN DE WISKUNDE IN DE REACTORTHEORIE, OP 30 EN 31 MEI 1960, TE DELFT. (Papers Presented During a Symposium on Applications of Mathematics to Reactor Theory, May 30-31, 1960, Delft). (Reactor Instituut Delft, Netherlands). 85p.

Seven papers are presented on mathematics in reactor theory. The titles are: Introduction to Transport Theory, Application of LaPlace Transformations in Reactor Calculations, The Use of Electronic Digital Computers for Reactor Calculations, Spherical Function Methods in Reactor Calculations, Variation Methods and Perturbation Theory, Slow and Delayed Neutrons in the Slurry Reactor of the KEMA, and Monte Carlo Methods for Reactor Calculations. (T.R.H.)

7008 (NYO-2676) HETEROGENEOUS REACTOR CALCULATION METHODS. Quarterly Progress Report No. 4 [for] January 1, 1960 to March 31, 1960. Carl N. Klahr and Lawrence B. Mendelsohn (TRG, Inc., Syosset, N. Y.). 78p. Contract AT(30-1)-2375. (TRG-129-QTR-4). OTS.

Progress is indicated in three areas of heterogeneous reactor calculations: (1) multiple fission and absorption resonance effects; (2) a critical appraisal of the heterogeneous parameters and a better physical understanding of their values; and (3) the acquisition of HERESY-1 calculating experience on D_2O lattices. The general plan of HERESY-2 is described. A start was made on the assembly and use of epithermal fission resonance data in the form of heterogeneous parameters. A discussion of the multiple resonance treatment and related topics is given. A critical analysis of the assumptions of the heterogeneous method was made, in connection with the evaluation of the parameters γ (thermal absorption) and A (single equivalent resonance absorption) that are used in HERESY-1. The problems of infinite complex lattices, the approach to criticality of a square lattice, and the analysis of spiked cores in D_2O were examined. A series of HERESY-1 calculations was carried out to examine the difference between square and hexagonal graphite-moderated lattice configurations. (For preceding period see NYO-2675.) (W.D.M.)

7009 (ORNL-2837) AN EXPERIMENTAL STUDY OF VORTEX FLOW FOR APPLICATION TO GAS-PHASE FISSION HEATING. J. J. Keyes, Jr. and R. E. Dial (Oak Ridge National Lab., Tenn.). June 13, 1960. Decl Aug. 15, 1960. 96p. Contract W-7405-eng-26. OTS.

An experimental investigation into the gas dynamics of a jet-driven vortex tube for application of a cavity nuclear reactor to rocket propulsion has shown that viscous retardation of the vortex motion is severe, because of a high level of turbulence near the periphery. Based on the experience gained in this study, it is estimated that the achievement of vortex strengths sufficient for practical application will require the use of small diameter tubes with appreciable expenditure of power for recirculation of the gas. The effect of the high degree of turbulence on the separation process near the periphery remains to be determined. The independent variables which were found to influence the vortex strength significantly for a given gas and temperature condition are the tube diameter, the mass flow rate per unit tube length, the injection velocity, and the wall pressure. Estimates of the degree of turbulence in vortex flow have been made from data on the variation in tangential velocity with radius. Virtual (total) viscosities near the periphery ranged from 30 to 700 times the molecular viscosity for tangential Reynolds numbers of from 4×10^4 to 2×10^5. Measurements of the position of the mole-fraction peak for separation of helium and a heavy vapor agreed with the theory for laminar flow. This suggests that near the center of the vortex tube where the peak developed the radial density gradient was sufficiently strong to suppress turbulence. It is concluded that the vortex reactor concept appears promising for application to nuclear rocket propulsion provided a satisfactory method can be devised for recirculation of the large excess mass flow required to maintain the vortex strength, and if turbulence does not appreciably limit the separation process. A separation experiment at elevated temperature appears to be the next logical step in the research program. (auth)

7010 (ORNL-3016) NEUTRON DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 1, 1960. (Oak Ridge National Lab., Tenn.). Dec. 13, 1960. 338p. Contract W-7405-eng-26. OTS.

Research efforts in neutron physics are reported in the areas of light-water-moderated reactors, new reactors for BSF and TSF, critical experiments, experimental nuclear physics, experimental reactor physics, reactor theory, shielding research, radiation detector studies, plasma physics theory, and theoretical nuclear physics. Separate abstracts were prepared for the seventy sections of the report. (W.D.M.)

7011 (ORNL-3016(p.3-5)) REACTIVITY WORTH OF THE CENTRAL FUEL ELEMENT IN THE BULK SHIELDING REACTOR I. G. deSaussure, K. M. Henry, Jr., and R. Perez-Belles (Oak Ridge National Lab., Tenn.).

The reactivity worth of a BSR-1 fuel element at the center of a critical lattice was experimentally measured by a pulsed-neutron-source technique. The value obtained for BSR-1 loading No. 78 was 6.1 ± 0.5 dollars. (auth)

7012 (ORNL-3016(p.5-12)) THE MEASUREMENT OF THE EFFECTIVE DELAYED-NEUTRON FRACTION FOR THE BULK SHIELDING REACTOR I. J. D. Kington, R. Perez-Belles, and G. deSaussure (Oak Ridge National Lab., Tenn.).

The value of β_{eff}, the effective delayed-neutron fraction, was measured for a compact loading of the BSR-1 by the boron substitution technique. The value obtained was 0.0080 ± 0.0002. By adopting the literature value of the true delayed-neutron fraction, $\beta = 0.0064 \pm 0.0002$, the ratio of the effective delayed-neutron fraction to the true delayed-neutron fraction was found to be 1.25 ± 0.05. When this quantity was computed by a 3-group PDQ code calculation, the result was also 1.25, an agreement which indicates the validity of the computational method. (auth)

7013 (ORNL-3016(p.12-17)) PULSED-NEUTRON-SOURCE MEASUREMENTS AT THE BULK SHIELDING FACILITY. R. Perez-Belles, G. deSaussure, et al. (Oak Ridge National Lab., Tenn.).

The pulsed-neutron-source technique was employed to measure the characteristic time, l^*/β_{eff}, for several loadings of the Bulk Shielding Reactor 1 and one loading of the Puerto Rican Reactor. This technique also was used to measure the reactivity effect of various control-rod configurations in a 5 x 5 BSR-1 loading. Experimental values are compared with values calculated by existing reactor codes. Characteristic times ranged from 8.55 ± 0.28 to 11.2 ± 0.2 msec for BSR-1 loadings. Characteristic time for the PRR was 7.75 ± 0.18 msec. Control-rod worths vary over a considerable range, depending on position and number of rods employed. (auth)

7014 (ORNL-3016(p.18-25)) DIGITAL COMPUTER REACTOR CALCULATIONS AT THE BULK SHIELDING FACILITY. E. G. Silver, R. Perez-Belles, and B. Bonner (Oak Ridge National Lab., Tenn.).

The IBM 704 codes PDQ and GNU were extensively studied in an effort to improve the previously unsatisfactory agreement with experiment in the cases of reactors containing large, unfueled regions or containing heavily absorbing materials, such as control rods. Agreement with experiment is now of the same order as that previously observed only for compact reactor loadings. The codes were also applied to a number of problems of immediate practical interest at the BSF. (auth)

7015 (ORNL-3016(p. 29-41)) BULK SHIELDING REACTOR II: STATUS REPORT, INCLUDING SPERT TESTS. E. G. Silver and K. M. Henry, Jr. (Oak Ridge National Lab., Tenn.).

An extensive series of static and dynamic tests of the UO_2 - stainless steel core (BSR-2) for the BSF was completed at the SPERT-1 Facility of the National Reactor Testing Station. Static tests included measurements of the reactivity worth of the control system, temperature coefficients, void coefficients, and flux mappings. Transient tests included self-limiting excursions to peak powers of 226 Mw, where some deformation of fuel plates was observed. Controlled transient excursions employing the full control system, as well as others using only the level safety system, completed the program of tests. The reactor was returned to the BSF, and only final Safeguards Committee approval of realistic excess loadings is needed before it will be placed in routine operation. (auth)

7016 (ORNL-3016(p.42-53)) TOWER SHIELDING REACTOR II PRELIMINARY EXPERIMENTS. L. B. Holland V. R. Cain, et al. (Oak Ridge National Lab., Tenn.).

The TSR-2 preliminary experiments were completed, and the effects of design changes previously described were determined. The preliminary experiments included measurements of the reactivity worth of the shim and regulating rods for several core configurations, the temperature coefficient of reactivity, the void coefficient of reactivity for voids in each of two regions, the reactivity worth of the lead-boral shell around the core, the reac-

tivity effects of various shield materials outside the reactor pressure vessel, the radial flux through the core, and the prompt-neutron generation time. The heat flux throughout the core was recalculated on the basis of the measured thermal-flux distribution. (auth)

7017 (ORNL-3016(p.54-5)) PULSED-NEUTRON-SOURCE MEASUREMENTS AT THE TSR-II. G. deSaussure, E. G. Silver, and J. D. Kington (Oak Ridge National Lab., Tenn.).

A pulsed-neutron-source technique was employed to verify a calibration of the control system of the TSR-2 previously obtained by a combination of other methods. The results agreed with previous work. The reactivity worth of the entire control system was -4.77 ± 0.14 dollars. The value of the reduced generation time, l/β_{eff}, obtained by pulsed-neutron methods was 6.61 ± 0.20 msec. (auth)

7018 (ORNL-3016(p.59-70)) SOLUTION EXPERIMENTS IN A FLUX-TRAP CRITICAL ASSEMBLY: PRELIMINARY STUDY FOR HIGH FLUX ISOTOPE REACTOR. J. K. Fox, L. W. Gilley, and D. W. Magnuson (Oak Ridge National Lab., Tenn.).

A study of a flux-trap critical assembly was made, using a solution of $UO_2(NO_3)_2$ enriched to 93.5 wt. % in U^{235} and dissolved in mixtures of D_2O and H_2O. The assembly was a preliminary mock-up of the HFIR, and the data were intended to aid in the establishment of design parameters for the HFIR. Critical parameters, relative flux distributions, flux ratios, and the effects of centrally located air- or aluminum-filled "voids" were obtained. (auth)

7019 (ORNL-3016(p.76-8)) CRITICAL EXPERIMENTS WITH PRNC RESEARCH REACTOR FUEL ELEMENTS. E. B. Johnson and K. M. Henry, Jr. (Oak Ridge National Lab., Tenn.).

A series of critical experiments with the Puerto Rico Nuclear Center research reactor fuel elements was completed in the Pool Critical Assembly of the Bulk Shielding Facility. The experiments validated the computations on which the design fuel-plate loading was based, and they determined the amount of excess reactivity to be expected from three clean, cold loadings proposed by the reactor's designer as operational configurations. (auth)

7020 (ORNL-3016(p.129-30)) THERMAL-FLUX CALIBRATION IN SLOT 11 OF ORNL STANDARD GRAPHITE PILE. G. M. Estabrook (Oak Ridge National Lab., Tenn.).

A remeasurement of the thermal-neutron flux in slot 11 of the ORNL Standard Graphite Pile was made. Method and procedure followed those of a previous (1952) measurement. The value of the absolute thermal flux for 2200-m/sec (most probable velocity) neutrons was 635 ± 32 neutrons cm^{-2} sec^{-1}. The value for average-velocity neutrons was 716 ± 36 neutrons cm^{-2} sec^{-1}. The value from the previous calibration was 703 ± 35 neutrons cm^{-2} sec^{-1}. (auth)

7021 (ORNL-3016(p.136-41)) AN APPLICATION OF THE PULSED-NEUTRON TECHNIQUE TO REACTOR STUDY. R. Perez-Belles, G. deSaussure, and E. G. Silver (Oak Ridge National Lab., Tenn.).

The pulsed-neutron technique was used to measure the change in the buckling induced when a cadmium control rod was inserted into a beryllium moderating assembly. Measurements were made on various-sized assemblies with slim cylindrical rods, a cruciform rod, and rectangular, hollow box-like rods fabricated of cadmium sheet. Results were compared with predictions from calculations by the Nordheim-Scalettar method and from PDQ code calculations. Agreement was observed in the simpler cases with the cylindrical rods and, when the Hurwitz-Roe approximation was used to convert to a circular cylinder, in the case of the cruciform rod, but agreement of both Nordheim-Scalettar and PDQ calculations with experiment was poor for the large box-like rods. Inadequacy of diffusion theory as applied in the case of large rods is suspected, but a possible systematic error in the measurements is not ruled out. (auth)

7022 (ORNL-3016(p.156-61)) HOMOGENEOUS, INFINITE MEDIUM P_1 CODES. W. E. Kinney (Oak Ridge National Lab., Tenn.).

Multigroup codes, utilizing a consistent P_1 approximation to the Boltzmann equation, were written to compute neutron ages and Fourier transforms. Such codes not only are useful for production of reactor physics data, but will facilitate economical investigation of improvements to multigroup codes. Comparisons of code results with analytic and Monte Carlo results show good agreement. (auth)

7023 (ORNL-3016(p.161-6)) ANISOTROPIC SLOWING-DOWN PARAMETERS FOR CORN PONE. W. E. Kinney (Oak Ridge National Lab., Tenn.).

Two codes were written which permit the inclusion of anisotropic scattering in the center-of-mass system in Corn Pone calculations. The Legendre Polynomial Code employs the coefficients obtained in the expansion of the differential scattering cross section in a series of Legendre polynomials. The Differential Code uses the differential scattering cross sections directly. Input, operating instructions, output, and some typical results are given for each code. (auth)

7024 (ORNL-3016(p.166-8)) ADDITIONS AND CHANGES TO CORN PONE. W. E. Kinney (Oak Ridge National Lab., Tenn.).

A version of Corn Pone was assembled which incorporates codes to compute and use disadvantage factors. This version also includes the boundary conditions requisite to the assumption of isotropic currents entering a void. (auth)

7025 (ORNL-3016(p.169-83)) AN EXAMINATION OF SOME FEATURES OF CORN PONE, A MULTIGROUP, MULTIREGION REACTOR CODE. W. E. Kinney (Oak Ridge National Lab., Tenn.).

Several aspects of the Corn Pone design were evaluated by calculation of a simple reactor model in various ways and by calculation of neutron ages. Comparison of results with Monte Carlo results has assisted in the evaluations. It was indicated that use of the Corn Pone difference equations good to fourth order in the lattice spacing does not significantly improve results over those obtained by use of equations good only to second order. The assumption that the flux is constant over a group, rather than varying linearly, is adequate. Only for light water is there a significant difference between P_1 and diffusion theory results for coarse group structures (31 groups) and isotropic scattering. Differences of the order of 1% in multiplication constants, absorptions, and escapes were noted in comparing Goertzel-Greuling and usual multigroup age slowing-down treatments. A simpler age slowing-down

treatment which nevertheless gives better results was developed. (auth)

7026 (ORNL-3016(p.193-4)) THE O5R CODE: A GENERAL-PURPOSE MONTE CARLO CODE FOR THE IBM 704. R. R. Coveyou and J. G. Sullivan (Oak Ridge National Lab., Tenn.).

The O5R code, a general purpose Monte Carlo reactor code for the IBM 704 computer, was completed and successfully tested on manufactured problems to which the answers were known, age calculations, and, finally, a number of practical problems. It is expected that the main portions of the code will be unaffected by the replacement of the IBM 704 by the IBM 7090, scheduled for December 1960. At that time an improved model for thermal effects will be introduced into the code, and its versatility will be increased to allow a larger number of media and more flexible geometry routines than are presently available. (auth)

7027 (ORNL-3016(p.197-202)) LID TANK SHIELDING FACILITY MEASUREMENTS BEHIND THE ML-1 SHIELD MOCKUP. A. D. MacKellar (Oak Ridge National Lab., Tenn.).

Measurements of thermal-neutron flux, fast-neutron and γ-ray doses, and γ-ray dose as a function of time after shutdown were made behind a mock-up of the Aerojet-General Corp. ML-1 shield. The effects on γ-ray dose rates of various placements of the lead within the mock-up configuration were also investigated. (auth)

7028 (ORNL-3016(p.219-21)) DESIGN OF A SHIELD FOR THE OAK RIDGE RESEARCH REACTOR, SOUTH FACILITY (GCR LOOP NO. 2). D. K. Trubey (Oak Ridge National Lab., Tenn.).

Experimental and theoretical programs assisting in the design of a mobile shield for the ORR South Facility are being carried out. The shield is required for the installation of GCR loop No. 2, a test loop for evaluation of gas cooled reactor fuel elements. Experimental measurements were obtained at beam holes HS-1 and HB-2; four IBM 704 codes are being utilized in the theoretical program. (auth)

7029 (R59CAP3) PRELIMINARY PRESSURE DROP MEASUREMENTS OF SEVEN ELEMENT FUEL BUNDLES FOR NPD-2 REACTOR. L. H. Mensforth, I. D. Yonemitsu, and G. M. Barns (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.). Jan. 27, 1960. 28p.

A laboratory program that was undertaken in 1958 to determine head losses along short seven element fuel bundles for the NPD-2 Reactor is described. Tests were conducted using water at 70 and 120°F. Two different styles of end plates for the bundles were assessed. The pressure-drop measurement data were processed to obtain relations between head loss and flow rates. The components affecting head loss were evaluated separately, as well as in various combinations. The sums of applicable individual values agreed closely with the ones evaluated in combination. (auth)

7030 (RAG-16) LA DÉTERMINATION NUMÉRIQUE DU COMPORTEMENT DYNAMIQUE D'UNE PILE A L'AIDE D'UNE CALCULATRICE ÉLECTRONIQUE. (Numerical Determination of the Dynamic Behavior of a Reactor Using an Electronic Calculator). J. Patry (Reaktor A. G., Würenlingen, Switzerland). Apr. 1960. 28p.

The dynamic behavior of a reactor can be numerically determined in an acceptable period of time by a calculator of average speed. The method of the Duhamel integrals used has the advantage that the external reactivity can be varied discontinuously without affecting the precision adversely. The study of thermal effects is incorporated in the proposed program and does not entail any additional complications. (T.R.H.)

7031 (SRIA-25) CONTAINMENT OF FRAGMENTS FROM A RUNAWAY REACTOR. Summary Progress Report No. 2 [for Period] November 1, 1959–April 30, 1960. G. B. Huber and N. R. Zabel (Stanford Research Inst. Poulter Labs., Menlo Park, Calif.). 104p. Project No. 2. Contract AT(04-3)-115. OTS.

In order to extend earlier studies to longer periods which would overlap SPERT data, development of new energy sources was undertaken. This development of low-velocity high-energy explosive has had substantial success. Velocities in the vicinity of 1000 meters per second were obtained and measured by a variety of techniques. Even lower velocities appear feasible. Calorimetric measurements indicate more than adequate energy yield. Simulated reactor periods up to 20 msec should be possible with this explosive. Study of reactor model response to simulated runaways was extended to include additional reactor features, many of which were found to have significant influence on the response. Energy sources with entirely gaseous reaction products produced considerably greater fragmentation and fragment throw than sources with partly solid products. Magnitude of pressure pulses delivered by the source is responsible for the difference. Lowering the energy release rate from a 1- to 2-msec period results in substantial reduction of damage produced by the release. Simulated thermal shielding between model reactor vessel and model biological shielding allows an appreciable fraction of energy to be absorbed by the vessel wall or the shielding itself, reducing damage to the concrete. Reduction of concrete shielding thickness by 25% results in a large increase in shielding fragmentation. Lack of confinement of vessel contents (no lid on vessel) had little effect on damage produced in model excursions. Approximate calculations of pressure rise inside the model reactor vessel gave a maximum value of 13,000 psi for any of the model energy releases currently in use. Actual pressures are expected to be lower because of several processes, neglected in the calculations, that absorb minor amounts of energy. Studies, both experimental and analytical, of steel plate penetration were extended. Apparatus for prestressing small-scale target plates was designed and constructed. Preliminary penetration experiments with the apparatus showed that a measurable reduction in penetration resistance can be produced by prestressing the target. In small-scale tests, penetration was achieved in moderately stressed plates with projectile energies reduced as much as 11%—compared with energies required to penetrate unstressed targets. Penetration tests with large steel projectiles of 1-in.-thick targets that conform to the specifications for steel in reactor vapor container shells indicated at least 20% lower resistance to penetration than low-carbon aluminum-killed mild steel which had fine grain structure and 30% lower tensile strength. These results indicated that current standards are not sufficient to indicate dynamic resistance of steel. Penetration tests of ordinary mild steel with large concrete projectiles showed that neither enhanced dynamic compressive strength nor sevenfold excess in kinetic energy over that required of steel projectiles is effective for achieving penetration. Calculations indicated that a con-

crete missile diameter greater than 2 ft is necessary for the missile to penetrate 1-in. steel plate. (For preceding period see SRIA-2.) (auth)

7032 (VDIT-20) FUEL CHARGING SYSTEMS. A BIBLIOGRAPHY OF SELECTED LITERATURE. Ernst Bock (Aktiebolaget Atomenergi, Stockholm). 1960. 24p.

Bibliography in a combination of English, French, German, and Swedish languages.

A selected bibliography is given dealing with fuel-charging systems. The bibliography covers (1) general construction aspects, special systems and economical problems; (2) patents; and (3) Swedish designs. (auth)

7033 (AEC-tr-4351) NEUTRON SPECTRUM IN HOMOGENEOUS SLAB REACTORS. (Neutronenspektren in Heterogenen Plattenreaktoren). W. Haefele. Translated by Melvin Tobias (Oak Ridge National Lab.) from Nukleonik 1, 197-208(1959). 32p. (Includes original, 12p.). JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 15735.

7034 (CEA-tr-A-804) CONTRIBUTION À LA THÉORIE DES RÉACTEURS À NEUTRONS RAPIDES. (Theory of Fast-Neutron Reactors). R. Schulten (Max-Planck-Institut für Physik, Göttingen). Translated into French from "Zur Theorie der Reaktoren Mit Schnellen Neutronen. (NP-6268) [1954?]. 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, abstract No. 6899.

7035 SIZING GAS-COOLED REACTOR CORES. A SIMPLIFIED METHOD FOR THERMODYNAMIC REQUIREMENTS. Thomas G. Flock (Convair, Ft. Worth, Tex.). Aerospace Eng. 19, 14-15; 80-2(1960) Dec.

A method for rapid calculation of reactor geometry for gas-cooled reactors to satisfy thermodynamic requirements is presented. It is useful for optimization and off-design studies and may be of assistance in estimating cooling passage sizes of shields and other heat sinks. (auth)

7036 EFFECTS OF A PARTLY INSERTED ABSORBING ROD ON THE DENSITY DISTRIBUTION OF A NEUTRON FLUX. J. Chermak and L. Trlifaj (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague). Atomnaya Energ. 9, 470-6(1960) Dec. (In Russian)

A calculational method is suggested for evaluating the efficiency of a cylindrical control rod partially inserted into an unreflected reactor. The method affords a relatively simple calculation of the neutron flux density in the vicinity of the rod. A one-group equation, $\Delta\varphi + B^2\varphi = 0$, with special boundary conditions at the rod surface is used. The value B^2 and the corresponding flux distribution φ are calculated for various rod positions. (tr-auth)

7037 MAGNETIC POSITION INDICATORS FOR REACTOR CONTROL RODS. Einar Medal (Knolls Atomic Power Lab., Schenectady, N. Y.). Automatic Control 13, No. 3, 29-31(1960) Sept.

Magnetic reed switches were developed as position indicators for reactor control rods. The most effective system appeared to be a single switch placed in the bottom of a thimble telescoping into a hollow lead screw. This screw carried an array of permanent ring magnets stacked with opposing poles facing each other the entire length of the stroke. When a single switch passed the stacked magnets, a pulse was received and then transmitted to a stepping motor. The stepping motor turned a potentiometer that furnished the read-out to the control circuitry. Position indication intervals of $\frac{1}{4}$ in. were reliably furnished. A device that could indicate pole-slip was designed to furnish complete position indication during normal operation without the need of a thimble sensor. (M.C.G.)

7038 METHODS TO MEASURE PHYSICAL PARAMETERS OF HETEROGENEOUS REACTOR CORES BY EXPONENTIAL EXPERIMENTS. [PART] II. S. Tassan (Brookhaven National Lab., Upton, N. Y.). Energia nucleare (Milan) 7, 673-84(1960) Oct. (In Italian)

The methods used to measure the thermal utilization factor, fast fission factor, resonance escape probability, and initial conversion ratio of heterogeneous reactor cores are described. (B.O.G.)

7039 AN EXTENSION OF A VARIATIONAL CALCULATION BY KUSHNERIUK AND MCKAY TO EVALUATE THE EXTRAPOLATION LENGTH OF FUEL AND ABSORBER ELEMENTS. B. Montagnini (AGIP Nucleare, Milan). Energia nucleare (Milan) 7, 724-35(1960) Oct. (In English)

Kushneriuk and McKay's variational method, devised to evaluate the extrapolation length of cylindrical rods, is extended to treat rather complicated fuel or absorber elements. This is accomplished by generalizing the treatment of certain escape probability functions which play a fundamental role in this method, so that the geometrical structure of the element is properly accounted for. The general variational formalism has been left unaltered. (auth)

7040 A DERIVATION OF THE TIME-DEPENDENT ADJOINT EQUATIONS FOR NEUTRON IMPORTANCE IN THE TRANSPORT, CONTINUOUS SLOWING-DOWN AND DIFFUSION MODELS. Jeffery Lewins (Massachusetts Inst. of Tech., Cambridge). J. Nuclear Energy, Pt. A. Reactor Sci. 13, 1-5(1960) Oct.

A generalization of the conventional importance concept is to consider the contribution of any one neutron to some final operationally determinable characteristic of a nuclear reactor. Consistency requires that one neutron is as important as its progeny. From these ideas, the adjoint equations and boundary conditions are derived for the Boltzmann transport model, for simple and multigroup diffusion theory and for the continuous slowing-down model. This more general concept for the time-dependent importance includes the conventional expressions of iterated fission probability, etc. as special cases. (auth)

7041 THE MONATOMIC GAS MODEL FOR THERMAL NEUTRON DISTRIBUTIONS IN A PHYSICAL MODERATOR. W. W. Clendenin (Westinghouse Electric Corp., Pittsburgh). J. Nuclear Energy, Pt. A. Reactor Sci. 13, 25-34(1960) Oct.

Comparison of infinite medium spectra of monatomic gases with varying ratios of atomic mass to neutron mass was made and shows similarity of the spectra for low absorption and disparity for high absorption. Spectra of the scalar flux and the neutron current in large geometry were also computed and used to obtain the thermal neutron diffusion length of the monatomic gas. The possibility of duplicating the scalar flux and the diffusion length of a physical moderator by means of a monatomic gas of suitable mass ratio is emphasized. A model of this type which reproduces the thermal neutron distribution in light water is obtained and the variation with temperature of the diffusion length of the model is compared with experiment. (auth)

7042 TWO PLUTONIUM–METAL CRITICAL ASSEMBLIES. G. A. Jarvis, G. A. Linenberger, J. D. Orndoff,

and H. C. Paxton (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 525-31(1960) Dec.

Two plutonium-metal critical assemblies were studied at the Pajarito site in Los Alamos. Part I describes Jezebel, the bare plutonium assembly, and gives its observed characteristics along with a few comparisons with enriched-uranium systems. Part II covers Popsy, a plutonium core in a thick normal-uranium reflector. As Popsy was relatively inflexible—intended only for a preliminary survey—its experimental program was much less complete than that of Jezebel. (auth)

7043 GENERAL SOLUTION OF THE REACTOR KINETIC EQUATIONS. G. R. Keepin and C. W. Cox (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 670-90(1960) Dec.

The reactor kinetic equations are reduced to an integral form convenient for explicit numerical solution, involving no approximations beyond the usual space-independent assumption. Numerical evaluation is performed by the RTS (Reactor Transient Solution) code, written in FORTRAN II for the IBM-704 computer. The characteristic roots and residues which arise in this method of solution were computed and are tabulated for each of the main fissile species. Analytic or point-function reactivity variation may be introduced, together with constant or time-varying reactivity compensation, and the resulting power response, total energy release, and compensated reactivity computed precisely as functions of time. The code solves the general non-equilibrium kinetics problem with extraneous sources, the customary equilibrium solution being a special case of the general solution. Practical use of the method is demonstrated through computed response curves for representative reactivity-addition functions in various types of chain-reacting systems. (auth)

7044 GODIVA II. AN UNMODERATED PULSE-IRRADIATION REACTOR. T. F. Wimett, R. H. White, W. R. Stratton, and D. P. Wood (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 691-708(1960) Dec.

Design features of Godiva II, the improved pulsed-reactor successor to Lady Godiva, are discussed together with characteristics of power excursions, and performance is compared with that of the original Godiva. Measurements of the wait time between stepwise reactivity insertion and the occurrence of a burst are presented and compared with theory based on a statistical model of fission chains. Analytical and numerical solutions of the reactor equations are developed to reproduce experimental data and extrapolate to higher energy release. Consideration is also given to perturbations arising from room-returned neutrons. Two different modes of operation are discussed and some design problems of Godiva-type pulsed reactors are briefly mentioned. Typical bursts are illustrated with peak powers up to 13,000 Mw and widths at half-maximum down to 35 μsec. (auth)

7045 DELAYED-NEUTRON-GROUPS NUMBER REDUCTION. A. Kirchenmayer (Technische Hochschule, Stuttgart). Nuclear Sci. and Eng. 8, 720-1(1960) Dec.

By reducing the number of the delayed neutron groups, the ease of handling reactor kinetic equations is increased. A discussion is given of two procedures which have been proposed for determining the constants for the smaller number of delayed neutron groups. The relative abundance factors and the decay constants are given for both procedures for thermal fission of U^{235}, approximating with two groups. Results calculated by the proposals are compared to exact solutions using as an example a transient for step reactivity. The principles of the two procedures are combined and the constants set is determined for the introduction of three delayed neutron groups. By this set the decay curve, $D(\tau)$, is approximated in the whole time range, $0 \leq \tau \leq 5$ sec. (B.O.G.)

7046 REACTOR-MATERIALS PROPERTIES. Stan J. Paprocki and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Nucleonics 18, No. 11, 154-61(1960) Nov.

Properties of reactor materials chosen on the basis of development and current interest are summarized in ten tables. Included are mechanical properties; physical properties; irradiation parameters; creep and rupture properties of fuels and structural materials; compatibility of fuel with structural materials, compatibility of structural materials with various coolants; and suitability of properly clad fuels having cladding defects for use in various coolants. (M.C.G.)

7047 THERMAL PROPERTIES OF NUCLEAR REACTOR MATERIALS. William S. Farmer (Allis-Chalmers Mfg. Co., Washington, D. C.). Nucleonics 18, No. 11, 162-5 (1960) Nov.

Thermal properties of reactor materials of current interest are outlined in tables and graphs. Specific heat, thermal conductivity, and viscosity or linear expansion coefficient are given for gas coolants at atmospheric pressure, liquid-metal coolants, liquid coolants other than liquid metals, solid moderators, control-rod materials, shielding materials, water, and water vapor. The effects of irradiation and exposure temperature on the thermal conductivity of graphite are also given. (M.C.G.)

7048 REACTOR-MATERIALS PRICES. Karl M. Mayer (Lockheed Aircraft Corp., Marietta, Ga.). Nucleonics 18, No. 11, 166-7(1960) Nov.

Prices for fuel, structural, and other reactor materials are given to permit comparison of competing materials. The materials are presented in two broad categories: those available only from the AEC because of federal regulation or current lack of commercial sources and those available commercially. (M.C.G.)

7049 STRESS AND TEMPERATURE DISTRIBUTIONS. Ralph Hankel (Nuclear Development Corp. of America, White Plains, N. Y.). Nucleonics 18, No. 11, 168-9(1960) Nov.

The significant temperature and stress distribution equations for various elemental heat generating geometries are presented in chart form. The geometries evaluated include flat plates, solid cylinders, cylindrical shells, solid spheres, and spherical shells. (M.C.G.)

7050 GAMMA RAYS FROM THERMAL-NEUTRON CAPTURE. E. Troubetzkoy and H. Goldstein (Nuclear Development Corp. of America, White Plains, N. Y.). Nucleonics 18, No. 11, 171-3(1960) Nov.

Data on γ rays from capture of thermal neutrons were compiled with the needs of reactor shielding being considered. Intensities of γ rays in seven energy intervals from 0 to >9 Mev are listed for various nuclei. For nuclei in which the energy spectra consist of discrete lines, a supplementary table which lists line energies and intensities is included. (M.C.G.)

7051 NEUTRON SELF-SHIELDING. P. F. Zweifel (Univ. of Michigan, Ann Arbor). Nucleonics 18, No. 11, 174-5(1960) Nov.

Determination of the rate of neutron capture in small,

heavily absorbing samples by the self-shielding approach is discussed. The self-shielding factor, f, is defined by the equation $f = \bar{\phi}_s / \phi_\infty$, where $\bar{\phi}_s$ is the average flux inside the sample and ϕ_∞ is the flux that would be present at the sample position if the sample was absent. The self-shielding factor was calculated for monoenergetic neutrons and resonance-energy neutrons incident on a resonance absorber. (M.C.G.)

7052 NUCLEAR-FUEL BURNUP CONVERSIONS. P. R. Huebotter (Atomic Power Development Associates, Inc., Detroit). Nucleonics 18, No. 11, 176-7(1960) Nov.

Burn-up conversion nomographs for eight fuel systems including bulk ceramic fuels, U-Mo and U-Nb alloys, and dispersion fuels are given. Burn-up units not included on the vertical scales can be calculated with the formulas provided. (M.C.G.)

7053 A HUMAN-ENGINEERED REACTOR CONTROL PANEL. David E. Dickey (Westinghouse Electric Corp., Pittsburgh). Nucleonics 18, No. 12, 80, 82(1960) Dec.

Control-panel layouts that provide information in a more meaningful form are discussed. Such a panel usually can use the same components as a normally engineered panel, and circuitry was found to be simpler. Functionally, the panel console is designed with three sections—for operating, monitoring, and reference. These console sections and some design suggestions are discussed. (M.C.G.)

7054 RELATIVE WORTH OF CONTROL MATERIALS. John L. Russell, Jr. (General Electric Co., Pleasanton, Calif.). Nucleonics 18, No. 12, 88, 90, 92(1960) Dec.

A semiempirical treatment of resonance absorption in control elements is proposed. The simplification is based on the postulate that, for slab-type control elements, any resonance absorber can be replaced by an equivalent amount of boron, which will have the same epicadmium absorption rate, and that this boron equivalence is the same for all thermal reactors. The boron equivalence was determined for 18 control elements of cadmium, hafnium, and indium, as a function of thickness, with ordinary coupon experiments in a low-enrichment water-moderated critical assembly. (M.C.G.)

7055 A METHOD FOR COMPARING REACTOR CONTROL MATERIALS. T. J. Pashos, G. D. Ritland, and J. L. Russell, Jr. (General Electric Co., San Jose, Calif.). Nucleonics 18, No. 12, 94, 96, 98, 100(1960) Dec.

A short analytical method was developed for preliminary comparison of the economics and reactivity worth of available control materials. The surface density of an absorber material in a slab-type control rod was related to the reactivity worth and nuclear life by this method. The method assumed that the basic nuclear and physical parameters of the reactor to be studied are established. The minimum relative worth the system needs to control the reactor at the maximum reactivity condition was first calculated. The second step was to determine the control system lifetime. As an example of how the method may be applied, the lifetimes and costs calculated for various control materials in the Experimental Boiling Water Reactor control rod system are given. (M.C.G.)

7056 CAN-1: FOG-COOLANT PROJECT. M. Silvestri (Centro Informazioni Studi Esperienze, Milan), E. Bernsohn, and G. Sofer. Nucleonics 19, No. 1, 86-8 (1961) Jan.

Fog-cooling, wherein the reactor coolant is a dispersion of water droplets in steam, is under development for possible application to light-water-moderated reactors. The advantages of a steam-water mixture are lower coolant density, reduced thermal stresses, high heat-transfer coefficients, direct cycling, negative pressure coefficient of reactivity, and high specific power. The problems encountered are: the fog must be produced at the inlet of each reactor channel; steam-recirculation pumps are required; coolant velocity may pose an erosion problem; and coolant stability depends on its quality and flow rate. Fog-cooling is applicable to various types of reactors: water-moderated (light and heavy water), graphite-moderated, and possibly fast reactors. The projected work is outlined according to the tasks of Centro Informazione Studi Esperienze, Ansaldo Company, and Nuclear Development Corp. of America. The CAN-1 design parameters are tabulated. (B.O.G.)

7057 THE PHYSICS OF NUCLEAR REACTORS. Yu. I. Klimov. Priroda 49, No. 10, 42-5(1960) Oct. (In Russian)

It is noted that a series of five reactors (BR-1, BR-2, BR-3, BR-4, and BR-5) were successively constructed to develop the theory and practice of fast neutron reactors. The last reactor of this series (BR-5) put on stream in the summer of 1958 with a power of 5000 kilowatts can be considered as the prototype of future, fast neutron, power reactors. Brief mention is made of three research reactors (VVR-2, VVR-S, and IRT) which use distilled water as a moderator and heat transfer medium. A schematic drawing of the IRT research reactor is presented. Twelve research reactors were built in the USSR and various satellite countries. The names of people associated with the development of these reactors are given prominence as Lenin prize winners. (TTT)

7058 THERMAL REACTOR THEORY. A. D. Galanin. Second Revised and Authorized Edition. Translated from the Russian by J. B. Sykes. International Series of Monographs on Nuclear Energy. Division X. Reactor Design Physics. Volume 3. New York, Pergamon Press, 1960. 425p. $15.00.

A comprehensive account of thermal nuclear reactor theory is given covering the following topics: neutron diffusion and slowing down, reactor critical size, neutron behavior in homogeneous media, heterogeneous reactors, perturbation theory, time variation of nuclear fuel, delayed-neutron kinetics, temperature coefficient, control, Boltzmann equation, and heterogeneous reactor theory. (D.L.C.)

7059 IMPROVEMENTS RELATING TO MECHANICAL HANDLING APPARATUS FOR NUCLEAR REACTOR FUEL ELEMENTS. David Reginald Davies (to Metropolitan-Vickers Electrical Co., Ltd.). British Patent 852,027. Oct. 19, 1960.

A loading and unloading apparatus for gas-cooled reactors is invented comprising a structure situated inside the pressure vessel under the core and rotatable about a vertical axis. Means are provided for positioning a fuel carrier on the structure at a selected radial distance from the axis of rotation and for actuating the carrier to load or unload fuel elements. The details and operation of the structure are discussed and illustrated in five drawings. The fuel carrier is fully described in Patent Serial No. 852,028. (D.L.C.)

7060 IMPROVEMENTS RELATING TO MECHANICAL HANDLING APPARATUS FOR NUCLEAR REACTOR FUEL ELEMENTS. David Reginald Davies (to Metropolitan-

Vickers Electrical Co., Ltd.). British Patent 852,028. Oct. 19, 1960.

A description is given of a fuel carrier to be used with a loading and unloading apparatus for gas-cooled reactors as described by Patent Serial No. 852,027. The fuel carrier, having a magazine rotatable about a vertical axis and provided with supports for fuel rods, is placed underneath a fuel channel for the loading and unloading operations. A pivoted loading arm moves the fuel elements. Drawings are included. (D.L.C.)

7061 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock & Wilcox Co.). British Patent 852,177. Oct. 26, 1960.

A control system for D_2O-cooled and moderated reactors is described which has stationary control elements and provides sensitive reactor control. The control elements are tubes into which BF_3 gas is pumped for neutron absorption purposes. In operation, the control is varied by changing the temperature of the BF_3 liquid in the closed control circuit, thus adjusting the gas pressure. (D.L.C.)

7062 NUCLEAR REACTOR INCLUDING A PACKAGE SAFETY DEVICE. (to U. S. Atomic Energy Commission). British Patent 852,366. Oct. 26, 1960.

A D_2O-cooled and moderated reactor is designed with an auxiliary safety device which is reliable, simple, and sabotage-proof. The device comprises a tube containing two chambers, the first in a favorable position in the reactor for neutron absorption purposes and the second in a remote position and containing He^3 at 114 atm. The chambers are separated by a barrier consisting of a stainless steel ring surrounding a copper disk and a U^{235} mass in thermal contact with the copper disk; when the neutron flux exceeds a certain level (10^{13} neutrons/cm^2/sec) at the barrier, the U^{235} melts the copper, releasing the gas into the first chamber. In other words, the device functions as a nuclear fuse. Although this safety device is described in conjunction with a D_2O reactor, it should be adaptable to all reactors. (D.L.C.)

7063 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Geoffrey Herbert Haines, Raymond Hicks, and Keith James Mitchell (to General Electric Co., Ltd.). British Patent 852,840. Nov. 2, 1960.

A supporting arrangement for reactor pressure vessels is designed so that the vessel is suspended from rigid support means by a plurality of suspension members pivotally attached at both ends to the vessel. The vessel is shaped so that the coolant pressure opposes the bending stresses induced in the vessel at the points of suspension, and arrangements are made to suspend the reactor core within the vessel from the same support means. The advantages of this arrangement are that there is no tendency of the support members to buckle, the vessel has greater freedom to expand or contract with temperature or pressure changes, and stresses in the vessel are greatly reduced. This arrangement is suitable for use with gas-cooled reactors having core support structures such as those described by Patent Serial No. 852,839. Drawings are included. (D.L.C.)

7064 IMPROVEMENTS IN OR RELATING TO COOLING SYSTEMS FOR NUCLEAR REACTORS. Ronald Scott Challender and August Roumph (to United Kingdom Atomic Energy Authority). British Patent 852,957. Nov. 2, 1960.

A re-entrant cooling system for a graphite-moderated, sodium-cooled reactor is designed comprising inner and outer concentric tubes disposed between the hot and cold sodium tanks in such a manner that cold sodium enters the outer tube, flows over the fuel elements, and then exits to the hot sodium tank via the inner tube. The tubes and ports for sodium passage are designed so that the flow rate is controlled by rotating the inner tube relative to the outer tube. (D.L.C.)

7065 IMPROVEMENTS IN NUCLEAR REACTORS. (to Beteiligungs-und Patentverwaltungsgesellschaft mit Beschränkter Haftung). British Patent 853,051. Nov. 2, 1960.

Reflector efficiencies may be increased simply by maintaining the reflector at a high temperature, and this can be brought about either by running heated coolant through it or by encasing it in a heat insulator. (D.L.C.)

7066 IMPROVEMENTS IN DEVICES FOR SUPPORTING AT LEAST THE SOLID MODERATOR OF A NUCLEAR REACTOR HAVING VERTICAL CHANNELS. (to Commissariat à l'Énergie Atomique). British Patent 853,083. Nov. 2, 1960.

A device for supporting the solid moderator of a reactor with vertical channels is designed so that a fluid-tight connection is made between a channel and the coolant circuit despite the Wigner growth. The device comprises a tubular member interposed between the bottom of the channel and the top of the coolant circuit and provided at its lower end a spherical bearing surface to make a fluid-tight connection while permitting small relative angular displacements between the member and the circuit. Several configurations of this device are presented. (D.L.C.)

7067 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS AND METHODS OF MAKING SUCH ELEMENTS. (to General Dynamics Corp.). British Patent 853,750. Nov. 9, 1960.

A reactor fuel element is described which comprises a mixture of a particulate fissionable material, particulate zirconium hydride, and a matrix of a radiation-resistant metal and a closed, corrosion-resistant container. This element, of the solid homogeneous type, is designed for research reactors, especially those described in Patent Serial No. 852,877. The fissionable material has an average particle size of 1 to 50 μ, while that of the zirconium hydride ranges from 5 to 1000 μ, and the hydride concentration is from 60 to 90% of the mixture. The matrix may be one or more of the metals aluminum, magnesium, lead, and bismuth, but the container usually is aluminum. Burnable poisons such as cadmium, samarium, erbium, or boron, or mixtures of these, may be incorporated up to 1% in the mixture to control the fission process. The various processes involved in fabricating such fuel elements, e.g., preparing zirconium hydride, comminuting, mixing, pressing the mixture, and sealing the container with the mixture, are described in detail. Two examples of fuel element fabrication are included. (D.L.C.)

7068 REFLECTOR COOLING. (to United Kingdom Atomic Energy Authority). British Patent 854,121. Nov. 16, 1960.

A reactor was designed comprising a graphite moderator, uranium fuel rods inserted in the moderator, an aluminum casing surrounding the moderator, tubes in the casing for passage of helium as coolant, and a reflector surrounding the moderator. Reflector cooling as a means of reactor cooling is discussed. (D.L.C.)

7069 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Walter Humbach (to Siemens-Schuckertwerke A. G.). British Patent 854,549. Nov. 23, 1960.

A heterogeneous reactor can be made to approach the ideal reactor lattice with spherical fuel elements arranged like atoms in a crystal lattice by having two or three sublattices of fuel rods nestled one within the other and with their directions perpendicular. With this type of lattice, the resonance capture quota is greatly reduced, resulting in a reduction of the reactor dimensions. (D.L.C.)

7070 IMPROVEMENTS RELATING TO GAS TIGHT COUPLINGS. George Camac (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). British Patent 854,763. Nov. 23, 1960.

A coupling between a pair of ducts is designed in which the ducts are provided with chamfered mating surfaces to form an annular joint, servo apparatus are carried on one duct to operate hook members engaging the flange on the other duct, and channels are provided around one of the mating surfaces. In operation, gas under pressure is passed into the channel to test the seal. A possible variant of this design is described in which a flexible hosing is interposed between the two ducts. This method of coupling can be used for gaining access to a fuel channel of a gas-cooled reactor without coolant loss, as for a charging machine such as that described by Patent Serial No. 854,764. Drawings are included. (D.L.C.)

7071 IMPROVEMENTS RELATING TO NUCLEAR REACTOR CHARGING APPARATUS. Donald Mason Sutherland and Philip Rawson Tipper (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). British Patent 854,764. Nov. 23, 1960.

A shielded chute charging apparatus and a fuel charging-discharging machine with a grab mechanism are designed for use with graphite-moderated, gas-cooled reactors. Full details of their design and operation are given together with drawings. (D.L.C.)

7072 IMPROVEMENTS RELATING TO POSITION INDICATING APPARATUS FOR LINEARLY MOVABLE OBJECTS. Derek Moore and Hugh James Poulter (to English Electric Co., Ltd.). British Patent 854,819. Nov. 23, 1960.

An apparatus for indicating the position of a reactor control rod attached to a cable wound spirally on a drum is designed comprising a Magslip type electric receiver and transmitter with a pinion on its shaft engaging a rack on a carriage, the carriage in turn engaging the thread of a screw which is driven through bevel gears by the winding drum. The pitch of the screw is varied progressively so that the carriage movement is directly proportional to the control rod movement and a linear scale can be used on the Magslip receiver. (D.L.C.)

7073 IMPROVEMENTS RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS AND TO NUCLEAR REACTORS USING SUCH ELEMENTS. Arthur Shillitto, Terence Ingham, and Douglas Frank Seymour (to English Electric Co., Ltd.). British Patent 854,882.

A reactor fuel element for vertical fuel channels in graphite-moderated reactors is designed with a plurality of struts arranged for movement between a retracted position, in which the element can move freely in the channel, and an extended position, which allows the struts to engage supporting ledges in the channel and thus to center and support the element. Drawings are included. Some aspects of the design are given in Patent Serial No. 854,883. (D.L.C.)

7074 IMPROVEMENTS RELATING TO NUCLEAR REACTORS AND TO FUEL ELEMENTS THEREFOR. Henry Shull Arms (to English Electric Co., Ltd.). British Patent 854,883. Nov. 23, 1960.

A reactor is designed with fuel channels extending through a core built of graphite layers with their direction perpendicular to the layers. The channels and the fuel elements are designed with recesses, spiders, and lugs so that the fuel elements are centered in the channels by means of the lugs abutting the recesses. An independent support is provided for each fuel element, and electric contacts can be made to temperature-responsive devices on the fuel elements. Details of the channel-fuel element design are given in Patent Serial No. 854,882. (D.L.C.)

Power Reactors

7075 (ACNP-6008) PATHFINDER ATOMIC POWER PLANT. IBM-704 PROGRAM FOR REACTOR CONTAINMENT, PRESSURE SUPPRESSION ANALYSIS. E. E. Mason and W. M. Chmielewski (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). July 15, 1960. 65p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS.

A research and development program to investigate the feasibility of eliminating vapor closure for the Pathfinder Reactor was conducted. The major inquiry under the feasibility study involved an analysis of the complex transient conditions occurring in the reactor cavity, the pump rooms, and the entire reactor building following a primary system rupture. To solve the simultaneous nonlinear set of equations evolving from the heat, mass, and force balances in the system, an IBM-704 digital computer program was developed. The program has a very general input and can therefore be used with other containment designs. Input parameters include: initial pressures in reactor and throughout the containment building, heat capacity of vessel, decay heat, feedwater flow rate, enthalpy of feedwater, and volume of primary coolant system. (auth)

7076 (AECU-4140(Suppl.1)) PROJECTION OF COSTS, 1959-1975, FOR NUCLEAR-CONVENTIONAL POWER PLANT COST STUDY; CONVENTIONAL COAL FIRED POWER PLANTS, 25,000 KW TO 325,000 KW, FOR ARGONNE NATIONAL LABORATORY, LEMONT, ILLINOIS. (Sargent and Lundy, Chicago). July 2, 1959. 45p. (SL-1564(Suppl.1)). OTS.

A year by year projection of costs is shown for the period 1959 to 1975 of the cost data included in AECU-4140. Projections are made for investment, fuel, and operating costs for 25, 60, 100, 200, and 325 Mw plants. The largest and average size turbine generator units that will be placed in service in 1968 and in 1975 are predicted. (W.D.M.)

7077 (AECU-4140(Suppl.2)) SUPPLEMENTAL DATA FOR NUCLEAR-CONVENTIONAL POWER PLANT COST STUDY; CONVENTIONAL COAL FIRED POWER PLANTS, 25,000 KW TO 325,000 KW. FOR EVALUATION AND PLANNING BRANCH, DIVISION OF REACTOR DEVELOPMENT ATOMIC ENERGY COMMISSION. (Sargent and Lundy, Chicago). Sept. 1, 1959. 48p. (SL-1564(Suppl.2)). OTS.

Projected investment costs (1959 to 1975) are given for conventional coal-fired power plants of 25, 60, 100, 200, and 325 Mw capacity. Estimated power generation costs are given for coal priced at 25, 30, and 35 cents per million BTU and for the largest nominal size turbine-generator unit in service in 1959, 1968, and 1975. (W.D.M.)

7078 (APAE-77) SM-1 RESEARCH AND DEVELOPMENT PROGRAM, LONG-LIVED INDUCED ACTIVITY

BUILDUP DURING SM-1 CORE I LIFETIME TASK XVIII—PHASE I. C. A. Bergmann (Alco Products, Inc., Schenectady, N. Y.). Nov. 30, 1960. 142p. Contract AT(30-3)-326. OTS.

The results of activity buildup studies in the SM-1 performed during Core I lifetime are reported. Data are presented on the extent, nature, and mechanism of the buildup of long-lived γ-emitting nuclides in the reactor primary system. Radiation levels after reactor shutdown are presented, as well as mathematical equations used to account for the observed activity levels. The data have shown that Co^{60} is the major contributor to radiation levels in the SM-1. Co^{60} activity arises from the cobalt in Haynes 25 alloy flux suppressors, and the cobalt impurity in stainless steel. After 35 months operation at an average power level of 55%, deposited Co^{60} activity accounted for approximately 83% of the total radiation level (mr/hr) contributed by the long-lived γ-emitting nuclides. The contribution of the primary coolant activity to the total radiation level is insignificant when compared to the contribution of the activity deposited on the walls of the system. The radiation level on the super-heater side of the steam generator was about 1400 mr/hr after 35 months of reactor operation. The percentages of Co^{60} activity in the coolant and in the deposits were not the same. This indicates either that nuclides are depositing irreversibly on the surfaces of the system or that all nuclides are not exchanging at the same rate. The ratio of Co^{58}/Co^{60} in the deposits shows that a major fraction of the nuclides are irreversibly deposited. Mathematical equations derived during the course of work were used to predict the observed activity build-up on SM-1 primary system surfaces. Certain constants in the equations were obtained from the experimental data. Calculated values of activity levels based on the equations were in good agreement with the activity levels found on the primary system. The equations may be used to determine the effect of cobalt (or other impurities) on deposited activity. (auth)

7079 (APAE-Memo-267) SM-2 SINGLE ELEMENT; FINAL TEST REPORT. P. S. Krause (Alco Products, Inc., Schenectady, N. Y.). Oct. 28, 1960. 137p. Contract AT(30-3)-326. OTS.

Tests were conducted on an SM-2 control-rod assembly and stationary element to determine channel-to-channel coolant flow distribution and static pressure drops across both the control-rod assembly and stationary element, and to select proper top and bottom core support configurations necessary to bring stationary element channel-to-channel flow distribution within prescribed limits of ±6% of element average. Results showed control-rod channel-to-channel flow distribution was +7.0% and −7.4% of element average, within required ±12%. Pressure drop across the control-rod assembly was measured as 29.0 ft of water (80°F) at design flow rate of 331 gpm. First-pass stationary-element pressure drop was measured as 17.1 ft of water (80°F) at a flow rate of 272 gpm. The flow distribution was +7.7% and −10.7% of element average, not within prescribed ±6%; but since actual element flow was much higher than required by thermal design, the flow profile was felt acceptable. Second-pass stationary-element pressure drop was measured as 28.8 ft of water (80°F) at a flow rate of 346 gpm; channel-to-channel flow distribution was +4.3% and −4.5% of average element velocity at a flow rate of 346 gpm, within prescribed limits of ±6.0%. (auth)

7080 (DANATOM-03-60) SAFETY CONSIDERATIONS ON THE BETA DESIGN STUDY. (Danish Assn. for Industrial Development of Atomic Energy, Hellerup). Sept. 1960. 39p.

An estimate is provided of the off-site radiation hazards associated with operation of Beta, a 175-Mw gas-cooled nuclear power station. Investigations are described which cover an analysis of the radiological effect of normal reactor operation and some accidents caused by equipment failure or maloperation of the plant. Safety features inherent in the reactor design, as well as emergency organization requirements, are discussed. (W.D.M.)

7081 (DP-555) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT [FOR] OCTOBER 1960. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Dec. 1960. 30p. Contract AT(07-2)-1. OTS.

At the end of October about 43% of the Heavy Water Components Test Reactor (HWCTR) construction was complete. Pneumatic pressure testing of the containment building revealed some leaks that are in the process of being sealed. Optimization studies are being undertaken for the various heavy-water-moderated natural-uranium-fueled reactor concepts that appeared to have economic promise in earlier studies. During an irradiation test at low temperature a Zircaloy-2-clad swaged uranium oxide tube apparently failed, probably because of an inadequate end cap weld. Uranium oxide fuel elements were compacted by sonic vibration to 93% of theoretical density in the form of Zircaloy-clad rods; the technique is being extended to the compaction of at least 90%-dense oxide tubes. Heat-transfer burn-out data were obtained for forced convection boiling of water at 1000 psi. (For preceding period see DP-545.) (auth)

7082 (DPR/INF/256) THE POTENTIALITIES OF NUCLEAR POWER. P. T. Fletcher (United Kingdom Atomic Energy Authority, London). Apr. 1960. 11p.

A lecture on nuclear power economics and various reactor types is presented. (T.R.H.)

7083 (GA-1235) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Summary Report for the Period January 1, 1959 – December 31, 1959 and Quarterly Progress Report for the Period October 1, 1959–December 31, 1959. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 1960. 206p. Contract AT(04-3)-314. OTS.

The HTGR prototype plant (Peach Bottom Power Reactor) is being designed to produce steam at 1450 psi and 1000°F and to have a net capacity of 40 Mw(e). The fuel temperatures and gas pressures will be approximately the same as those required for larger plants. The reactor data and operating conditions for the graphite-clad core are given. The reactor and primary coolant systems are described. The prospects for development of the graphite-clad fuel element in time for use in the first loading of the reactor were improved by important advances in methods of fabrication and testing of both fuel compacts and graphite sleeves. The hot-pressing process for making fuel compacts was used successfully to make full-size compacts with a uniform distribution of ThC_2-UC_2 particles. Three irradiation capsules were fabricated and inserted in a test reactor to determine fuel compact and sleeve performance under HTGR conditions of irradiation and temperature. Two of these ran satisfactorily for the scheduled time of operation. A scope design study of the in-pile loop that will be used to evaluate the full-diameter graphite-clad

element was completed. Experiments to determine the extent of fuel migration within the element were undertaken. Preliminary results indicated that the central fuel-element temperatures must not exceed 2300°C for routine operation. An important start was made in developing an understanding of how to treat the neutron thermalization process in high-temperature graphite reactors. Analytical techniques for calculating the thermal neutron spectra in poisoned graphite media were developed and programmed for the IBM 704 computer. The experimental technique of measuring neutron spectra by using a pulsed linear electron accelerator was demonstrated by measurements made with boron-loaded graphite. A mockup of a small portion of the reactor core was constructed and operated to determine the local heat-transfer coefficients and pressure drop in the tricusp-shaped coolant passage. Initial results indicated that the variation of the heat-transfer coefficient around the circumference of the element is less than expected. Studies were started of the transient temperatures and stresses developed in the pressure vessel as a result of load changes or a scram. A detailed study of several types of steam generator for use in the nuclear steam supply system was completed. A design incorporating a steam drum was selected for further study. Preliminary flow diagrams were completed for the helium-purification and fission-product trapping systems. Adsorption isobars for selected fission products in activated carbon were measured and will be used in the detailed design of the trapping system. Detailed planning of the experimental reactor physics program was initiated. Progress was made in the identification of the principal safeguards problems for this type of reactor, and a preliminary safety analysis of the plant was completed. (auth)

7084 (GA-1778) NUCLEAR SAFETY CONSIDERATIONS AFFECTING THE DESIGN OF THE MARITIME GAS COOLED REACTOR. W. C. Moore (General Atomic Div., General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.). Nov. 1960. 21p. Contract AT(04-3)-187. OTS.

Presented at the International Atomic Energy Agency Symposium on Nuclear Ship Propulsion, Taormina, Italy, November 14-18, 1960.

The MGCR and its propulsion machinery are briefly described, and the possible hazards involved in operation of an MGCR-powered ship are discussed. The MGCR is a thermal reactor with slightly enriched UO_2 as fuel, BeO as moderator, reflector, and diluent, and helium as coolant. The coolant enters just above the core, flows downward outside the thermal shield and then up through the lower grid plate. The helium enters at 1120 psia and 745°F and leaves at 1345°F through orificed ports in the fuel channels. The turbomachinery is four axial-flow machines in one housing (a high-pressure high-temperature turbine driving two compressors at 12,200 rpm and a low-pressure turbine operating at 7500 rpm for propulsion). The accident situations considered include start-up accident, cold coolant accident, flooding of core, loss of coolant, fuel-element failure, loss of propulsion plant load, flooding, sinking, and salvage. Analysis of these emergencies leads to the conclusion that the reactor is inherently safe. (T.R.H.)

7085 (HW-66215(p.14-17)) LATTICE PARAMETERS FOR THE EXPERIMENTAL GAS COOLED REACTOR. J. R. Worden and P. F. Nichols (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The final experiment of a series in the PCTR, designed to support the EGCR program, has been completed. Values of K_∞ and f were measured using standard PCTR techniques. The fuel consisted of 2.6 wt. % enriched UO_2. Results for a 21.875-in. cell are given. (W.D.M.)

7086 (HW-66215(p.18-23)) PCTR MEASUREMENT OF THE REACTIVITY EFFECT OF A STAINLESS STEEL LOOP TUBE IN THE EGCR. P. F. Nichols and J. R. Worden (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Multiplication was measured for a 3 × 3 array of EGCR cells fueled with 1.8 wt. % UO_2, with the center fuel element replaced by an empty type-304 stainless steel tube (outside diameter of 4.468 in. and wall thickness of 0.187 in.). In a second measurement an EGCR seven-rod cluster fueled with 2.6 wt. % UO_2 fuel without a graphite sleeve was inserted into the same stainless steel tube, and K_∞ was again measured for the 3 × 3 array; k_∞ increased from 1.029 ± 0.010 to 1.067 ± 0.006. (W.D.M.)

7087 (HW-66215(p.24-6)) EGCR LATTICE RADIAL AND ANGULAR POWER DISTRIBUTION—2.6 w/o ENRICHMENT. P. F. Nichols (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Measurements are reported for EGCR lattice radial and angular power distribution using UO_2 enriched to 2.6 wt. %. Results are presented graphically. (W.D.M.)

7088 (LAMS-2495) QUARTERLY STATUS REPORT ON TURRET REACTOR EXPERIMENT FOR PERIOD ENDING NOVEMBER 20, 1960. (Los Alamos Scientific Lab., N. Mex.). Nov. 1960. 37p. Contract W-7405-eng-36. OTS.

Intensive effort was devoted to thermal and stress analysis of the more critical items in the primary coolant system. Calculated temperatures in the reactor pressure vessel are around 500 to 550°F, and combined stresses from pressure and temperature are below the allowable value of 26,250 psi. The large core-support-bearing temperature is calculated to be about 600°F. The main heat exchanger and heat recuperator were released for bids, and bid drawings for a number of other components are nearing completion. Nuclear calculations were made relating to fuel storage, initial core loading, and start-up source requirements. Latest shielding calculations still indicate the need for a supplemental thermal shield, for which a Boral liner of the pressure vessel is the favored choice. Hot pressing of zirconium diboride (ZrB_2) appears to provide the high-density compacts required for control rods. Preliminary tests in cladding molybdenum tubing with tantalum were successful. In the study of simple methods for fuel recycle, results continue to be encouraging. Several methods of partial decontamination were successfully tried in a solution which included La^{140} to test the chemical behavior in a high level of β activity. In other experiments, a combination of carbonate-scavenging and peroxide-precipitation steps resulted in removal of over 94% of the calculated β activity, with unremoved zirconium accounting for most of the residual activity. A second fuel-element irradiation test was initially successful but was terminated after three days because of thermocouple failure. Major simplifications were made in the gas clean-up system by the elimination of the duplicate copper oxide bed and by the deletion of provisions for regeneration of the large carbon beds. The function of the latter is now to delay xenon and krypton by dynamic adsorption for a sufficient period to permit sub-

stantial decay of the more radioactive isotopes. Under steady-state conditions a small amount of radioactivity will be returned in the effluent from the gas clean-up system. Delays have occurred in the design of the reactor facility itself because of the high construction costs estimated for the tentative facility layouts. Revisions are being studied which are expected to permit large cost reductions. However, as a result of accrued delays, it is expected that first critical experiments will not be possible before Dec. 1962. (auth)

7089 (NAA-SR-Memo-5326) SRE STANDARD OPERATING PROCEDURES. R. E. Durand, O. G. Jenkins, L. L. Johnson, E. N. Pearson, and L. E. Vorderbrueggen (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 27, 1960. 2 in. thick. Contract AT-11-1-GEN-8. OTS.

General SRE operating instructions, limits, and procedures are listed. Specific operating instructions are given for the reactor, sodium heat-transfer systems, sodium service systems, service cooling system, helium system, nitrogen and dehumidification systems, vent system, liquid waste system, fuel handling machine, building ventilation systems, wash cells, emergency power system, pump coolant systems, crane operation, off-normal conditions, and special procedures. (W.D.M.)

7090 (NYO-9400) AN EVALUATION OF FOSSIL SUPERHEAT FOR NUCLEAR POWER PLANTS. (Ebasco Services, Inc., New York). Oct. 1960. 2 in. thick. Contract AT(30-1)-2524. OTS.

The results of a study of the evaluation of fossil fuel superheat in nuclear power plants are presented. Alternate combination plant thermodynamic cycle parameters and principal component equipment design and performance characteristics, over a broad range of plant sizes, were studied with the objective to select the unique combination of factors which would yield the lowest combination plant energy cost. Conceptual designs were prepared for a broad range of sizes as dictated by the results of the optimization studies. Pressurized water, boiling water, and organic reactors were considered. (W.D.M.)

7091 (PRDC-TR-38) MONTHLY TECHNICAL REPORT [FOR] PERIOD AUGUST 1960. (Power Reactor Development Co., Detroit). 60p. Contract AT(11-1)-476. OTS.

Fermi Fast Breeder Reactor design progress and major component fabrication status are summarized. Reports are included from an environmental radioactive survey. (W.L.H.)

7092 (WCAP-4048) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT. Monthly Progress Report [for] November 1960. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). 27p. OTS.

Brief summaries are given for the development activities on nuclear design, pressure tube assembly development and analysis, fuel development, irradiation experiments and analysis, materials development and fabrication techniques, chemical surveillance and evaluation of CVTR materials and systems, component development, plant system, plant safety analysis and evaluation, and critical experiment. (W.D.M.)

7093 (CEA-tr-A-704) RÉACTEURS À HAUTE TEMPÉRATURE. (High-temperature Reactors). R. F. Benenati. Translated into French from Schweiz. Bauztg. 74, 533-45(1956). 57p.

A treatment is given of reactors from their origin to the present, especially the high-temperature types. Among these, the best adapted are the gas-cooled reactors. Some misleading designs and erroneous conclusions are discussed. The advantages and disadvantages of this type of reactor are compared with some others. The designs of gas-cooled reactors, their fuels, and over-all construction are discussed. (R.G.C.)

7094 THE CONTROL AND INSTRUMENTATION OF A MARINE REACTOR. R. Anscomb and F. Hutber (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Joint Panel Nuclear Marine Propulsion 4, 71-93(1960) Oct.

The behavior of reactors under transient conditions is not fully understood so the design of control and instrumentation systems for them is still in an early stage of development. This applies particularly to the more advanced systems, some of which offer the best development potential for marine propulsion purposes. For this reason this paper does little more than outline the nature of the problem and describe the fundamental reactor characteristics which must be taken into account and the basic mathematical equations used in designing a reactor control system. It points the way to possible solutions in particular cases and gives a general description of a typical control and instrumentation system which might be used in a ship. (auth)

7095 TWO YEARS OF HRE-2 OPERATION. Paul N. Haubenreich (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 8, 467-79(1960) Dec.

Nuclear operation of HRE-2 began in December 1957. In January 1960, the reactor was shut down for repair and modifications of the core tank. During this two-year period, operation of HRE-2 went far toward attaining the original goals of the experiment. It was possible to operate continuously for periods of up to three months; with the exception of the core tank, the life of components exceeded expectations. The maintenance which was required was shown to be practicable. Continuous removal of neutron poisons during operation and excellent containment of radioactivity were demonstrated. The general corrosion rate proved to be moderate to low. Although the experience was generally good, at some operating conditions fuel solution instability was observed when the reactor was operated at power. Uranium which separated as a result of the solution instability sometimes caused reactivity excursions. Uranium deposits in the core led to hot spots and two holes were melted in the thin Zircaloy-2 tank which separated the core and the blanket. Core modifications were designed to alleviate the conditions which led to fuel instability, and future operation will test the effectiveness of the changes. (auth)

7096 POWER REACTORS AND EXPERIMENTS THE WORLD AROUND. Nucleonics 18, No. 11, 148-53(1960) Nov.

The essential features of power reactors in operation or planned are summarized in tabular form. The reactors are grouped by type of coolant. The table includes information on power, fuel, moderator, coolant, steam generation, designer, builder, owner, and operator. (M.C.G.)

7097 FLUIDIZED BED FOR ROCKET PROPULSION. L. P. Hatch, W. H. Regan, and J. R. Powell (Brookhaven National Lab., Upton, N. Y.). Nucleonics 18, No. 12, 102-3 (1960) Dec.

A reactor concept for rocket propulsion in which the fuel in the form of particles would form a rotating fluidized bed

that would heat the hydrogen propellant as it passes through is proposed. Two ways in which the required centrifugal force on the fuel particles could be achieved are to rotate the fuel bed with a tangential flow of coolant gas into the reactor core and to rotate the core vessel itself. The reactor would be of the "cavity" type described by Safanov. (M.C.G.)

7098 ANP HTREs FULFILL TEST GOALS. Gunnar Thornton and Ben Blumberg (General Electric Co., Cincinnati). Nucleonics 19, No. 1, 45-51(1961) Jan.

Performance results from the Heat Transfer Reactor Experiment (HTRE) test series have measured up to or exceeded expectations. The series has involved three reactor systems (HTRE-1, HTRE-2, and HTRE-3) and two reactor concepts (water-moderated and ZrH-moderated). HTRE-1 achieved a number of full-power runs which demonstrated conclusively the feasibility of operating a jet engine on nuclear power, and easily passed a 100-hr endurance test at fuel temperatures to 1850°F, operating a single J-47 jet engine at power levels of 18.5 Mw. The HTRE-2 consisted of a mechanical modification of HTRE-1 to serve as a test facility for advanced fuel and moderator sections. The HTRE-3 system differed from HTRE-1 and -2 in that it had a solid ZrH-moderator and an air-cooled core structure, where the others were water-cooled and -moderated. The HTRE-3 system was tested with parallel J-47 engines at 32.4 Mw. Since the HTRE-3 core was designed for air flow of 850 lb/sec and the requirements of the jets were 123 lb/sec, it is seen that when coupled to an engine system of greater capacity the HTRE-3 could conceivably develop a correspondingly higher power level. The design concepts and operational characteristics of the three reactor systems are described. Specifics are given on the performance of HTRE-3. Design, mechanical, nuclear, and thermodynamic data are included for HTRE-1. (B.O.G.)

7099 TRENDS IN SODIUM EQUIPMENT. Robert W. Dickinson and John B. Williams (Atomics International, Canoga Park, Calif.). Nucleonics 19, No. 1, 65-70(1961) Jan.

A discussion is given of the experiences encountered with the mechanical components of sodium-cooled reactors. Because most of the components were adapted from designs for petroleum and water service, they fail to exploit sodium's superior heat-transfer ability and fall heir to thermal-stress problems. New designs alleviate these problems while fresh concepts forge the way toward 2200-psi 1050 to 1200°F steam. The chronology of sodium-cooled reactors is outlined. The failures encountered in the Seawolf and SRE are described. Discussions are given concerning developments in heat exchangers, steam generators, piping and nozzles, valves, pumps, and instrumentation. (B.O.G.)

7100 OPTIMIZING CORE PERFORMANCE. W. A. Sutherland (General Electric Co., San Jose, Calif.). Nucleonics 19, No. 1, 80; 82; 84(1961) Jan.

A reactor core design or performance effectiveness parameter is described which involves both the coolant and maximum wall temperatures. An explanation is given of how such a parameter can be useful in core heat-transfer analysis, particularly in the preliminary design where a variety of alternatives is being examined. (B.O.G.)

7101 EVALUATION OF KIWI-A INSTRUMENTATION SYSTEM. Bryant L. Hanson (Edgerton, Germeshausen & Grier, Inc., Las Vegas, Nev.). Technical Memorandum No. L-23. Presented at the American Rocket Society, Semi-Annual Meeting, Los Angeles, California, May 9-12, 1960. Las Vegas, Nev., Edgerton, Germeshausen & Grier, Inc., [1960]. 14p.

The instrumentation system for Kiwi-A, being a functional part of the initial design in the Rover nuclear rocket power program, is called upon to provide more diversified and accurate test information than is required in evaluating a new phase in conventional power systems. The design concept requires an end-to-end error of 1% or less. Statistical evaluation of data gathered in a series of special experiments indicates that this design concept was achieved. This evaluation includes the error involved in digitizing the quantitative analog data by means of human readers using modified conventional reading equipment. The transducers used in this system must perform in a radiation environment. Included in the total error, is the error introduced in thermocouples by this radiation environment. (auth)

7102 SNAP 2 RADIATIVE-CONDENSER DESIGN. M. G. Coombs and R. A. Stone (Atomics International, Canoga Park, Calif.). Paper No. 1328-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 12p.

The design of a minimum weight radiative condenser for SNAP 2 requires the simultaneous consideration of many factors. These include two-phase mercury flow, a variety of heat transfer problems, meteoroid protection, and radiator geometry effects. The interactions between these problem areas are described, and the method by which a minimum weight radiative condenser for SNAP-2 was designed is presented. (auth)

7103 SNAP 2 SYSTEM AND VEHICLE INTEGRATION. D. J. Cockeram and R. L. Wallerstedt (Atomics International, Canoga Park, Calif.). Paper No. 1329-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 9p. $1.00.

The SNAP 2 system is discussed as an item of flight hardware. The effect of vehicle limitations such as structural loadings, environmental conditions, induced torque limitations, and vehicle configurational restraints is related to final APU design. Discussions of APU influence on vehicle design are covered. Although the various APU vehicle interactions and mutual constraints are important, it is shown that timely considerations of these factors can lead to orderly development of space systems utilizing nuclear APU's. (auth)

7104 SNAP THERMOELECTRIC SYSTEMS. A. W. Thiele and M. G. Coombs (Atomics International, Canoga Park, Calif.). Paper No. 1330-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 8p.

In the range of moderate electrical power requirements (~1 kw) thermoelectric power conversion techniques offer many advantages in the design of nuclear auxiliary power units for space application. The current temperature capability of the lead telluride class of thermoelectric materials, in the vicinity of 1100°F, can easily be met with the demonstrated performance of the SNAP reactor systems. Minimum system weights are obtained at Carnot cycle efficiencies of the order of 25%, yielding a total system efficiency of about 3%. SNAP 10, a 300-watt system is now under development. This system will have the capability to

withstand missile launch environment and accomplish complete orbital start-up. (auth)

7105 EVALUATION OF SNAP SAFETY FOR SPACE REACTOR APPLICATION. F. D. Anderson and J. G. Lundholm, Jr. (Atomics International, Canoga Park, Calif.). Paper No. 1335-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 15p. $1.00.

The major operational periods investigated for the safety of SNAP systems for space reactor applications are (1) shipment and integration period, (2) launch pad period, (3) launch period, and (4) re-entry period. All areas were investigated for possible safety problems. Results of these studies indicate that periods except re-entry can use presently known safety procedures to ensure safety of the SNAP systems. In addition to the routine safety procedures, decontamination and monitoring equipment as well as specific launch pad procedures will be necessary for emergency situations. Only the re-entry period contains areas which may present safety problems because of the uncertainty of re-entry burn-up and high altitude dispersal of the SNAP fuel elements. Until re-entry burn-up can be assured, orbital start-up and high altitude orbits (≈ 700 miles) can be used to assure safe re-entry. When re-entry burn-up and high-altitude dispersal is proved, the re-entry of SNAP units will not add significant contamination to the biosphere. (auth)

7106 THE EXPERIMENTAL AND ANALYTICAL PROGRAMS FOR RE-ENTRY BURNUP OF SNAP REACTORS. P. D. Cohn (Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.). Paper No. 1336-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 17p.

The use of nuclear power in space applications is complicated by the radiological hazards that would develop if a radioactive component of a nuclear system should re-enter the earth's atmosphere, strike the earth, and contaminate a portion of terrestrial surface. Because of these hazards, analytical and experimental programs are under way to study the possibilities of re-entry burn-up of these nuclear systems. The results of the preliminary analysis showed that complete re-entry meltdown, burn-up, and subsequent dispersion of radioactive material would take place for the SNAP 2 fuel elements above 200,000 ft. To facilitate analysis, step changes were postulated to occur in the equivalent radius of the re-entrant body to simulate the changing geometries as the system breaks up. The reactor and components were assumed to have a spherical geometry. With these assumptions the altitude for complete meltdown of the different components was calculated. The model with spherical symmetry was used, except for the actual SNAP 2 fuel rods which were treated individually as tumbling cylinders. A constant re-entry angle of 1° was assumed for the calculations (to approximate a decaying orbit), and each component was assumed to be completely melted without any vaporization before the next component was exposed to heating. The atmospheric density was described by: $\rho = \rho_0 e^{-\beta y}$. A similar analytical study was made for the SNAP 10 system. Results of this study predicted complete burnup for SNAP 10 fuel plates above 190,000 ft. The first phase of the experimental program consisted of heat transfer studies in which SNAP 2 fuel rods were subjected to simulated re-entry conditions in a continuous arc-jet. Excellent agreement was found between the experimental and analytical results and deviations between analysis and experiment were no greater than 10%; the analytical and measured ablation rates agreed within 10%. This agreement would tend also to verify the assumption of minimal vaporization. (auth)

7107 THE APPLICATION OF SNAP UNITS IN CURRENT SPACE VEHICLES. J. R. Wetch and J. G. Lundholm, Jr. (Atomics International, Canoga Park, Calif.). Paper No. 1337-60. Presented at the ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960. New York, American Rocket Society, 1960. 8p. $1.00.

The expected uses of SNAP systems with space vehicles which will be available during this decade are discussed. It is shown that existing booster vehicles have payload capabilities such that significant useful payloads can be carried in addition to a SNAP system. The advantages of employing SNAP systems in conjunction with electric propulsion devices and wide band communications systems are discussed. (auth)

7108 IMPROVEMENTS IN HEAT GENERATING AND UTILISING PLANTS. Anthony James Taylor (to Babcock & Wilcox, Ltd.). British Patent 851,754. Oct. 19, 1960.

A heat-generating and utilizing plant using a reactor is designed in such a manner that constant coolant temperature at the reactor inlet is obtained by controlling the effects of varying boiler loads. This control is accomplished by an automatic feed liquid regulating system which limits the heat exchange between the coolant and the economizer and thus eliminates one common cause of fluctuating inlet coolant temperatures. Drawings embodying the invention are included illustrating a reactor power plant with a steam generator, economizers, evaporators, and superheaters. (D.L.C.)

7109 IMPROVEMENTS IN PLANT PRODUCING ENERGY. (to Société Francaise des Constructions Babcock & Wilcox). British Patent 851,820. Oct. 19, 1960.

A power plant incorporating a boiling water reactor and steam turbines is designed so that the contamination of the turbine, condenser, and circuit system located outside the reactor vat is greatly reduced. This reduction is effected by applying the double circulation method where the reactor is divided into two steam-generating compartments, the first (A) being in parallel with a purifying system and the second (B) supplying steam to the turbine. In operation, the steam generated in A is completely condensed in a condensation vat supplying B with condensed steam from the turbine, while water is passed from B to A via a throttled port. Water is fed from A to a purifying vessel, e.g., an ion exchanger, and thence to the condensation vat. Thus, purification is carried out independently of the steam circuit, and contamination of the steam output is reduced. (D.L.C.)

Production Reactors

7110 COMPUTATIONAL SURVEY OF IDEALIZED FAST BREEDER REACTORS. William H. Roach (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng. 8, 621-51(1960) Dec.

A calculational survey of idealized fast breeder reactors is reported. Representative fuel (Pu^{239}, U^{235}, U^{233}), fertile (U^{238}, Th^{232}), structural (stainless steel), and coolant (sodium) materials are used in the calculations, references

providing information as to the substitutional effect of other materials. The calculational method is defined, input parameters are discussed, and results, such as critical mass, critical volume, initial breeding ratios, and spectral indices for the reactors, are tabulated. (auth)

7111 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Stanley Edgar Barden (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). British Patent 853,269. Nov. 2, 1960.

The reactivity of a fertile-fissile fuel reactor can be increased if the reactor is designed so that the ratio fertile-fissle atoms varies periodically in successive zones. Two possible fuel arrangements for accomplishing this are described for heterogeneous and homogeneous reactors. (D.L.C.)

Research Reactors

7112 (LNP-4727(Encl.(a))) GNL PROGRAM STATUS REPORT. Final Report [for] April 1–September 30, 1960. (Lockheed Aircraft Corp., Marietta, Ga.). 15p. Contract AF33(600)-38947.

Activities for the period are summarized including reactor operations, radiation effects support, nuclear measurements support, and nuclear safety. (T.R.H.)

7113 (NP-9361) AMENDMENT NO. 1 TO PRELIMINARY HAZARDS REPORT FOR UNIVERSITY OF WISCONSIN POOL-TYPE NUCLEAR REACTOR. C. J. DeBevec (General Electric Co. [Atomic Power Equipment Dept., San Jose, Calif.]). July 27, 1960. 28p. OTS.

An amendment to the Preliminary Hazards Report for the University of Wisconsin Pool-Type Reactor is presented. (W.L.H.)

7114 (NP-9539) BIOMEDICAL RADIATION RESEARCH FACILITY CONTAINING THE DASA–TRIGA REACTOR. ENCLOSURE I: GENERAL INFORMATION. ENCLOSURE II: HAZARDS SUMMARY REPORT. (GA-1502). (General Atomic Div., General Dynamics Corp., San Diego, Calif. and Holmes and Narver, Inc., Los Angeles). 157p. Contract NBy-27757. OTS.

A description of the DASA–TRIGA reactor and its site and experimental facilities is presented along with a nuclear analysis and an accident and hazards analysis. The reactor is to be located at National Naval Medical Center, Bethesda, Maryland, in a reinforced concrete building with an off-gas stack. The reactor will operate at 100 kw with peaks of 1 Mw for 10 min not to exceed 1 Mw/day. Pulsed operation allowing 15 msec pulses releasing 20 Mw-sec is possible. The core can be moved within the reactor tank to separate exposure areas. Its principal use will be neutron irradiation of animals. The principal safety feature is the negative temperature coefficient. The core will consist of about 90 U–ZrH_4 elements, 20%-enriched, clad in aluminum to a size of about $1\frac{1}{2}$-in.-dia. and $28\frac{1}{2}$ in. long. The reflector will be water alone or water and lead. (T.R.H.)

7115 (NP-9550) DEPARTEMENT TECHNIQUE DES REACTEURS RAPPORT D'AVANCEMENT, PREMIER TRIMESTRE 1960. (Department of Reactor Technology Progress Report, First Quarter, 1960). R. Cornet and G. de Maere (Brussels. Centre d'Étude de l'Énergie Nucléaire). Mar. 31, 1960. 12p.

Irradiations performed in the BR-1 are summarized. (T.R.H.)

7116 (NP-9551) DEPARTEMENT REACTEURS DE RECHERCHE RAPPORT D'AVANCEMENT, DEUXIEME TRIMESTRE, 1960. (Department of Reactor Research Progress Report, Second Quarter, 1960.). R. Cornet (Brussels. Centre d'Étude de l'Énergie Nucléaire). Sept. 1, 1960. 11p.

Operating experience, pile changes and additions, and experimental use of the BR-1 reactor for the period are summarized. (T.R.H.)

7117 RESEARCH REACTOR SERVICES. J. N. Anno (Battelle Memorial Inst., Columbus, Ohio). p.15-28 of "Institute of Nuclear Materials Management First Annual Meeting, Columbus, Ohio, June 20-21, 1960." Pittsburgh, Institute of Nuclear Materials Management, 1960.

A brief description of the Battelle Research Reactor and a detailed breakdown of its operating costs, particularly the fuel reprocessing costs, are presented. Several possible reprocessing schemes are discussed; it was decided to store the spent fuel elements until 4 or 5 cores are accumulated and then to reprocess them at one time. A fuel storage facility for this purpose is described. (D.L.C.)

7118 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND FUEL ELEMENTS THEREFOR. (to General Dynamics Corp.). British Patent 852,877. Nov. 2, 1960.

A reactor is designed with a prompt negative temperature coefficient of reactivity so that it will not be damaged if mishandled, e.g., by sending all of the excess reactivity through it, and with a long core life. The reactor core contains fuel elements fabricated from a homogeneous mixture of fissionable material and solid moderator, by which the temperature coefficient of reactivity is rendered instantaneous or prompt. The coefficient is made negative enough for reactor safety through fuel expansion, warm neutron, neutron leakage, and neutron Doppler effects and through the use of poisons which also prolong the fuel element life. Drawings are included for a 10-kw water-cooled research reactor operated at 40°C and giving an average core thermal flux of $\sim 10^{11}$ neutrons/cm^2/sec at 10 kw. An excess reactivity of 1.0 to 1.5% is provided to take care of fuel burnup and poison accumulation. Fuel elements for this reactor are covered in detail by Patent Serial No. 853,750. (D.L.C.)

WASTE DISPOSAL AND PROCESSING

7119 (ANL-6233) RADIOACTIVE WASTE DISPOSAL. Walton A. Rodger (Argonne National Lab., Ill.). Sept. 1960. 169p. Contract W-31-109-eng-38. OTS.

This report was prepared as text material to serve as a basis for a series of lectures for the International Institute of Nuclear Science and Engineering, Argonne National Laboratory.

Radioactive waste disposal is discussed, including origin and management of wastes; handling of gaseous, solid, and liquid wastes; reduction of liquids to solids; release of wastes to environment; ultimate disposal; and future problems. Extensive data tabulations are presented. (136 references). (T.R.H.)

7120 (CF-60-10-35) STRONTIUM SORPTION STUDIES USING NATURALLY OCCURRING ION EXCHANGE

MATERIALS. K. T. Thomas, D. G. Jacobs, T. Tamura, and E. G. Struxness (Oak Ridge National Lab., Tenn.). Dec. 5, 1960. 33p. Contract W-7405-eng-26. OTS.

Four naturally occurring materials, namely, vermiculite, variscite, Tennessee rock phosphate, and Florida pebble phosphate, were studied to determine the feasibility of their use in columns for the sorption of strontium from high pH, intermediate-level wastes produced at ORNL. With the exception of vermiculite, all materials were found to be effective in strontium removal. The addition of soluble phosphate to the waste solution remarkably improved the strontium-sorption characteristics of vermiculite, 100 ppm of PO_4^{3-} being a satisfactory concentration. A reduction in pH of the solution adversely affected strontium-removal properties of all the materials. All the materials showed beneficial effects with an increase of Ca^{2+} concentration in the solution, but the results were not very marked. An increase in the mass equivalent of strontium or sodium concentration did not show any beneficial effects for strontium sorption. (auth)

7121 (HW-67334) RESEARCH AND DEVELOPMENT ACTIVITIES, FIXATION OF RADIOACTIVE RESIDUES QUARTERLY PROGRESS REPORT FOR JULY–SEPTEMBER 1960. D. W. Pearce, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 15, 1960. 26p. Contract AT(45-1)-1350.

Waste calcination studies in the fluid bed calciner were continued using simulated high acid Purex wastes. Studies with the fluid bed waste calciner were continued using a feed of simulated high-acid Purex waste; results are described. Results of laboratory-scale-batch calcination studies of simulated Purex-type high-level waste are also discussed. Data from tests to find the effects of variables on calcination of caustic neutralized Purex waste are tabulated; run conditions and resulting powder characteristics are given. Laboratory studies of fixation of high- and low-level wastes were extended to include examination of other types of waste and experiments with new varieties of absorption media. High-level studies conducted with clear supernatant fluids indicate the possibility of a simple fixation process that may be applicable to many types of waste. Cation exchange properties of clinoptilolite and natural zeolites were compared for cesium selectivity. Micro plant tests made by passing Purex tank-farm condensate waste through ion-exchange materials are reported. Results are listed for clinoptilolite, synthetic apatite, and alumino-silicate ion exchangers. (For preceding period see HW-66571.) (J.R.D.)

7122 (MSAR-60-89) INDUSTRIAL SURVEY ON DECONTAMINATION OF RADIOACTIVE COMPONENTS. Technical Report No. 1. S. J. Rodgers and W. A. Everson (MSA Research Corp., Callery, Penna.). July 15, 1960. 30p. For Westinghouse Electric Corp. Contract NObs 67500, Subcontract No. 73-(00-935).

A total of 330 questionnaires was sent to 113 different companies to obtain information on currently used chemical and mechanical methods of decontamination. Completed returns were received from 63 companies (56%) representing a total of 75 replies. The data were compiled to give a representative cross section of standard decontamination practices. Many of the companies reported experience in decontaminating stainless steel (94%); carbon steel (73%) and Inconel (37%) were the next most frequently reported materials. Fission products (76%) were reported most frequently as the contaminants. Activated steel products (57%) ranked second. Water (87%) was the most frequently reported contaminating medium, with organics (48%) ranking second. Dosage rates upon receipt of the contaminated component ranged from < 10 mr/hr to 3 r/hr. The level to which a component is decontaminated depends upon its future use, but most companies decontaminate to < 1 mr/hr and 200 cpm/sq ft. Detergents (59%) were preferred for decontamination of nonadherent activity and brushing (83%) was the preferred mechanical aid. Acids (60%) are preferred for removal of adherent activity but their usage is limited to noncritical surfaces. Alkaline permanganate-ammonium citrate process (25%) was reported as used more frequently than the citric acid-EDTA process (16%). (auth)

7123 UTILIZATION OF AN EXPERIMENTAL DEVICE FOR EVALUATION OF GROUND DISPOSAL AT THE CENTER FOR NUCLEAR STUDIES AT SACLAY. Renè Amairs and Jacques Vaccarezza. Energie nucléaire 2, 166-80 (1960) May-June.

Experimental laboratory and field results of the percolation of H^3 and Sr^{90} through Saclay soil are presented. Using parameters introduced by Hiester, Vermeulen, and Kaufman permits satisfactory extrapolation of the results, providing the soil is homogeneous. The objectives of the study were to provide a disposal and control device of suitable form and capacity, capable of expansion in size and for following the movement of radioactive ions in soil, and to evaluate field conditions by study of laboratory soil columns of different dimensions and to observe in which cases the extrapolation to a soil on a site would be possible. (Public Health Eng. Abstr. 40 (1960) Dec.)

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